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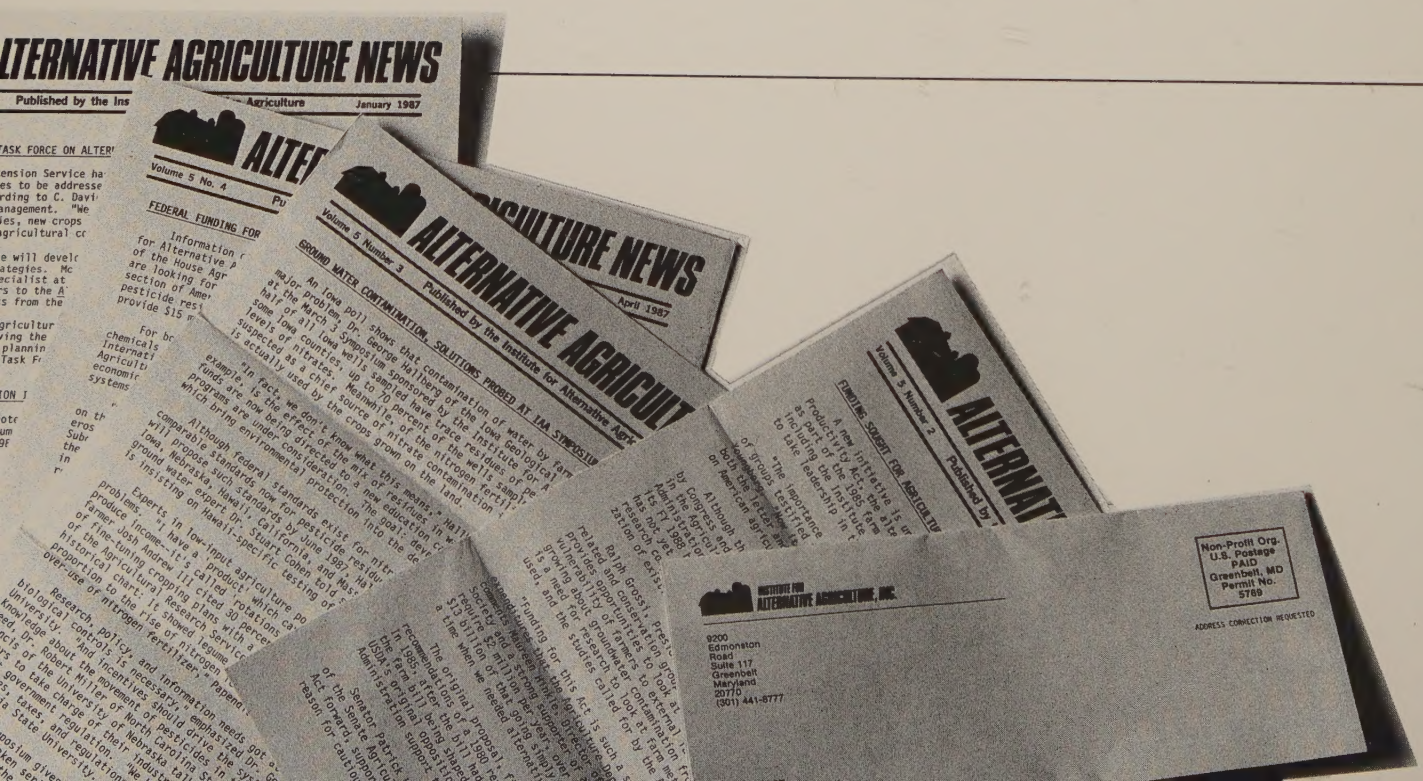
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Institute Information

The Institute for Alternative Agriculture is a nonprofit, tax-exempt research and education organization established in 1983 to encourage and facilitate the adoption of low-cost, resource-conserving and environmentally-sound farming methods. It works closely with producer groups, public research and education institutions, and government agencies in promoting a sustainable agriculture system.

Its programs include providing a national information clearinghouse, serving as a voice for sustainable agriculture in Washington, and developing and implementing research and educational outreach programs. It holds an annual scientific symposium and publishes a monthly newsletter.

The Institute is governed by a grass roots Board of Directors, which includes several commercial-scale organic farmers, and maintains a small professional staff. It is supported by memberships and donations and grants from foundations, corporations, and individuals.

Cover Photo

The cover photo shows corn being harvested from plots in a farm field in Jericho, Vermont. The experiment is designed to evaluate the effects of different nitrogen management systems on nitrate leaching to groundwater. Research Technician, Evan Stewart, is weighing silage samples. Photo provided by Dr. Hugh Brown, Department of Plant and Soil Science, University of Vermont, Burlington, VT 05405.

OPINION

Sustainable agriculture: A process at the community level

Paul B. Martin and Peggy Prather

Key words: Community development, rapid appraisal, rural development, sustainable process

As we interact with others working in sustainable agriculture around the country, we see an obvious gap in people's understanding of differing attitudes towards sustainable agriculture. Many seem to equate the concept to an inventory of appropriate technologies for a particular agroecological zone. Some, generally those labeled environmentalists, think of it in terms of conservation or preservation of natural resources that may be affected by agriculture. Consumer advocates usually think of it in terms of agricultural food products that contain no synthetic chemicals harmful to human health and that are raised without polluting the environment or depleting natural resources.

We prefer the scope of Harwood's (1990) definition of sustainable agriculture, i.e., one "that can evolve indefinitely toward greater human utility, greater efficiency of resource use, and a balance with the environment that is favorable both to humans and to most other species." Such a normative definition of sustainable agriculture implies a number of features about society and environment that go well beyond the limits of what are commonly considered communities and includes the concept of carrying capacity and equitable distribution of natural resources.

We believe that characteristics of sustainable agriculture are: that it involve whole communities; that it should be dependent on few external inputs; that it not require continuous crisis management; and that it should serve the needs of all members of the community, including the poorest. To convey this concept, we prefer the phrase conservation and sustainable community development (CSCD) (modified after Brundtland, 1987).

The opinions herein are of the authors and do not necessarily reflect the policy of the Texas Department of Agriculture.

Paul B. Martin was Coordinator and Peggy Prather was Research Analyst, Sustainable Agriculture, Texas Department of Agriculture, Austin, TX 78711 from 1988-90. Paul is currently staff entomologist, Texas Department of Agriculture, Austin TX 78711, and Peggy is currently Education and Project Director for Texas and Oklahoma, Center for Holistic Management, Albuquerque, NM 87914.

We feel that it is more effective in communicating the wh
concept and expresses the urgency of conserving resources b
ter to provide opportunity for lasting development towa
intra- and inter-generational equity and a building of real co
munity.

Another concern is the excessively technological focus
much of the current rhetoric of sustainable agriculture, for
ample, emphasis on specific alternative production practi
that are *alternatives*, to be sure, but still reflect a technologic
fix mindset. We believe our efforts should be invested inste
in a search for a sustainable framework in which to opera
This has been said many times before (e.g., Altieri, 1988; Sh
man, 1990) and was recently laid out well by Enshayan (199
Therefore, we feel strongly that those who are involved in s
tainable agriculture efforts must pay more attention to the pr
ess in which they are involved. This sustainable developm
process should be regularly evaluated to determine if, indeed
includes the following essential features:

—historical background of economic and social developm
in a specific community

—assessing of local natural and human resources

—defining community boundaries and determining need
action

—team building and leadership development

—goal setting, policy development, and planning action st

—testing management tactics

—financing strategic actions

—measuring sustainability, analyzing and evaluating,
justing and replanning

—and quality continuing education

The results must also be examined to ascertain that the proc
is indeed moving the system towards sustainability.

Knowledge of the historical background provides the foot

Continued on page

Managing nitrogen for sustainable corn systems: Problems and possibilities

Fred Magdoff

Abstract. *Excessive nitrogen fertilizer use in corn production has resulted in widespread nitrate pollution of ground water and economic losses for farmers. In addition, reliance on nitrogen fertilizers produced with large amounts of fossil fuels may not be economically or environmentally sustainable in the future. Although leaching of significant amounts of nitrate to the ground water is inherent in growing corn, several techniques are available for more environmentally and agronomically sound management. The following management practices are discussed in this article: sidedress as the main method of N fertilizer application; the pre-sidedress (Magdoff) nitrate soil test; farm-based nitrogen sources (manures, green manures, and rotations with sod crops); cover crops for lowering profile nitrate during the most likely period for leaching; and the end of season stalk nitrate test.*

Key words: nitrogen management, nitrogen fertilizers, corn systems, nitrate pollution, farm-based N sources

Introduction

Potential environmental problems from growing an annual row crop like corn include soil erosion and pollution of surface and ground waters by pesticides and nutrients. Since corn is currently such an important crop in the United States (grown on about 60 million acres) and no doubt will remain so for a long time, it is very important to develop sustainable ways to produce it. Two major sustainability issues regarding N management for corn are NO_3^- contamination of ground water and the large amount of fossil energy use in production of N fertilizers. Ground water pollution by NO_3^- associated with crop production is currently regarded as a major national environmental problem (Benbrook, 1989; OTA, 1990).

There are excellent reviews dealing with the nitrogen cycle or various aspects of N use in crop production (Hargrove (ed.), 1988; Hauck (ed.), 1984; Stevenson, 1986). The main purpose of this article is to evaluate the NO_3^- pollution potential associated with growing corn and to discuss available management options to limit NO_3^- contamination of ground water. N management practices that decrease reliance on non-renewable energy sources will also be discussed. The article will focus on conditions in the Northeast and humid portions of the Midwest.

Corn production and ground water nitrate pollution

Any NO_3^- left in the soil following the growth of corn may leach and eventually reach the ground water. It also could be immobilized by microorganisms, denitrified to N_2O or N_2 gas, or remain in the soil if conditions are not right for leaching. During the growing season, evapotranspiration tends to be greater than water infiltration into soil, so that NO_3^- does not usually leach to great depths (Allison, 1966). Following removal of the crop in the fall, there is no transpiration, and evaporation is greatly reduced as the weather cools. For these reasons, water will tend to percolate and NO_3^- will tend to leach most readily during the fall, winter (when the ground is not frozen), and early spring. The quantity of NO_3^- in the soil profile in the fall therefore can serve as an indication of the NO_3^- leaching potential. The actual amount of NO_3^- leached from fall until spring will depend on soil structure (water flow patterns) and the amount of precipitation that infiltrates the soil surface. Leaching will not occur when the soil is frozen. Fall profile NO_3^- can be very low if the corn was deficient in N or if an unusually high amount of precipitation caused significant leaching or denitrification. NO_3^- in the soil profile in the fall may be very high when the amount of N added as inorganic fertilizer or from organic sources is much greater than the crop's needs. This may also occur when corn receiving normal N fertilizer does not remove the usual amount of N because of poor yields, for example from drought.

The potential for NO_3^- pollution of ground water increases greatly when N is applied in excess of crop needs (Nelson and MacGregor, 1973; Jolley and Pierre, 1977; Legg and Meisinger, 1982; Roth and Fox, 1990). Until recently, the only generally accepted way to estimate N availability when making N fertilizer recommendations in the humid regions of the U.S. was to assume the effects of crop and manure management and possibly soil type. Recent research (see below) indicates that "insurance" was built into fertilizer recommendation systems in the form of excessive N rates to guard against N deficiency. Developing and implementing more accurate systems for making fertilizer N recommendations, such as the soil N test described

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below, is an important environmental goal (OTA, 1990; Benbrook, 1989).

Potential NO_3-N pollution resulting from good N management

It is clear that rates of N application above what is needed by the corn crop will result in the greatest NO_3^- ground water pollution problem. However, the potential pollution from N rates that are adequate but not excessive may also be significant.

The quantity of NO_3^- remaining in the soil profile after corn harvest can be used as an estimate of NO_3^- leaching potential. This quantity represents only the potential for NO_3^- leaching, since some portion may be denitrified or immobilized or remain in micropores as water flows mainly through macropores during the period of extensive leaching. Assuming that whole corn plants adequately supplied with N will contain 1.15 percent N (Stanford, 1973) and that about 10 percent of total N uptake will be in the lower stalk and roots, the N uptake for corn with a harvested yield of 17 tons/ha above ground dry matter (corresponding to a grain yield of about 9 tons/ha) is about 215 kg N/ha. If the uptake of net available N (after immobilization, denitrification, and leaching during the growing season) is 70 percent efficient, about 310 kg N/ha must be present in the soil during the season. The implication of this calculation is that, assuming no denitrification or immobilization, there will be about 95 kg N/ha left in the soil in late fall. This calculation is in general agreement with experimentally derived values for corn that has received an adequate but not excessive N supply, as estimated from yield response data. Corn in Pennsylvania fertilized with the economic optimum quantity of N on a variety of soils and with a grain yield of 7.6 to 11 tons/ha had fall NO_3-N to a depth of 1.2 m ranging from 41 to 138 kg/ha (Roth and Fox, 1990). Fall profile NO_3-N for adequately fertilized corn with a grain yield of 8 to 9 tons/ha in the second year of an experiment on three silt loam soils in Wisconsin was approximately 50 to 70 kg/ha to a depth of 1.2 m (Bundy and Malone, 1988). Fall profile NO_3-N was approximately the same (40 to 60 kg/ha to 1.2 m) for adequately fertilized corn with a silage yield of 13 to 14 tons/ha on loam and sandy loam Vermont soils over two years (calculated from data reported in Magdoff and Amadon (1980)). For adequately fertilized corn on silt loam and clay loam soils in Minnesota that yielded about 14 tons/ha silage, NO_3-N to 1.2 m ranged from 66 to 160 kg/ha (Jokela and Randall, 1989). Thus, from 40 to over 150 kg/ha of NO_3-N may remain in soil following corn, even without excess N fertilizer application.

It is likely that the NO_3-N concentrations of soil solution percolating beneath the rooting depth of corn that has been adequately supplied with N will be above 10 mg/liter (10 ppm). During the early part of the growing season, very high solution NO_3^- concentrations are needed to ensure adequate N nutrition. Work in the Northeast and Midwest on the newly developed soil test for N availability (see discussion below) has indicated that the critical value for NO_3-N in the surface 30 cm when corn seedlings are 20 to 30 cm tall is between 20 and 30 mg/kg (Magdoff et al., 1990). If the water content is 20 percent, the NO_3-N concentration of the soil solution early in the season will be around 100 to 150 mg/liter. If it is assumed that almost all N reaches corn roots as NO_3^- by mass flow, that plants take up 500 liters of water (mainly in the transpiration stream) to produce 1 kg of dry plant material, and that corn adequately supplied with N will require 0.0115 kg N/kg of plant, then the average NO_3-N concentration of the soil solution during the growing season must be 23 mg/liter (500 liters water/kg plant x 23 mg NO_3-N/liter water = 11,500 mg or 0.0115 kg NO_3-N/kg plant). Therefore, it is not surprising that soil solution NO_3-N has been found to be 14 mg/liter in the root zone of N-deficient corn (Broadbent and Rauschkolb, 1977). Average annual NO_3-N concentrations in tile drainage from plots receiving optimal N fertilizer rates (20 to 112 kg N/ha) were between 13 and 25 mg/liter over a three-year experiment (Gast et al., 1978). Calculations based on profile NO_3-N reported in Magdoff and Amadon (1980) indicate fall soil solution concentratio of between 10 and 20 mg/liter for co receiving adequate but not excessive nutrition from either sewage sludge fertilizer.

Thus, even if the crop has not receiv excess N, NO_3-N levels between 10 a 20 mg/liter in water percolating bel the root zone should be considered inherent part of growing corn. Disp sion within the water table may result concentrations below U.S. Public Hea standard of 10 mg NO_3-N/liter.

Organic vs. synthetic N sources

Some people believe that using orga sources of nutrients instead of synthe fertilizers will reduce leaching of nut ents to the ground water (U.S. Dept. Agriculture, 1980). Their reasoning that organic sources release N slow and more in synchrony with plant nee This makes the N less susceptible leaching than a large dose of fertiliz that is readily available because it is so ble and soon to be converted to NO However, even if mineralization of ganic materials provides the main sou of available N, a large pool of NO_3 must still be present by mid-June to ea July to satisfy the rapid uptake dema of corn during its grand period growth. To ensure adequate nutriti during the entire season, about 90 to 1 kg NO_3-N/ha must be present in the u per 30 cm of soil when corn is about cm tall (calculated from the critical s test values given above, assuming 1 ha soil to a depth of 30 cm weighs 4.5 m lion kg).

It is clear that very high rates of eit organic materials or synthetic N fertil ers have substantial potential for lea ing losses of NO_3^-. However, few expe ments have been designed to compa the leaching potential of N from orga and synthetic sources when both sup optimal amounts of available N. Co fort et al. (1987) found less NO_3^- in t soil profile with injected liquid manu than with synthetic N fertilizers and su gested that this was caused by enhanc denitrification associated with manu treatments. However, because of the c

ficulties of obtaining representative soil samples when manure is injected and the lack of yield data to determine whether N availability was comparable among treatments, this experiment may not prove that there is less NO_3^- pollution potential from manure than synthetic fertilizers. Profile NO_3^- levels in treatments with comparable N availability in other manure and fertilizer experiments frequently show little or no difference in apparent pollution potential (for example, see Xie and MacKenzie, 1986; Sutton et al., 1986). Although enhanced denitrification in the fall may occur with organic N sources, it is also possible for net mineralization from residual organic N to occur after N uptake by the crop has ceased. Even at the end of the growing season, relatively fresh residues such as manures, green manures, and decomposing sods will still be mineralizing N. This may help explain the finding of an experiment in Pennsylvania that there was more fall NO_3^- accumulation in the soil profiles of manured sites than non-manured sites when the economically optimum N rate was used (Roth and Fox, 1990).

Therefore, using organic N sources to supply the needs of corn does not appear to be a solution to NO_3^- pollution of ground water. However, using organic sources of fertility, especially those that come from the farm, is a desirable environmental and agronomic practice for other reasons, as discussed below.

Environmentally and agronomically sound nitrogen management practices

The following N management practices can either reduce NO_3^- pollution of ground water or decrease the use of synthetic N sources manufactured with a high energy input: sidedressing most fertilizer N; using the pre-sidedress nitrate soil test (PSNT), or Magdoff N test, to assess N availability; replacing synthetic N fertilizer by farm-based N sources, such as manures, N fixed by legumes in rotations or grown as green manure crops; establishing cover crops to decrease profile NO_3^- before the most likely leaching season; and using the end of season stalk NO_3-N test. The timing of the various N management practices is illustrated in Figure 1.

Sidedress application for most fertilizer N

The practice of applying most, or at least some, fertilizer N just before the plants have their greatest need for N has two advantages over earlier applications. Fertilizer N applied as a sidedress is sometimes used more efficiently by corn than N applied in fall or early spring (Lathwell et al., 1970; Welch et al., 1971). Applying fertilizer closer to the time when the plants actually need it means that less available N is lost by leaching, denitrification, or immobilization. In addition, relying on sidedress for most fertilizer N means that fertilizer recommendations to farmers can be more accurate when done in connection with the new soil test for N availability discussed below.

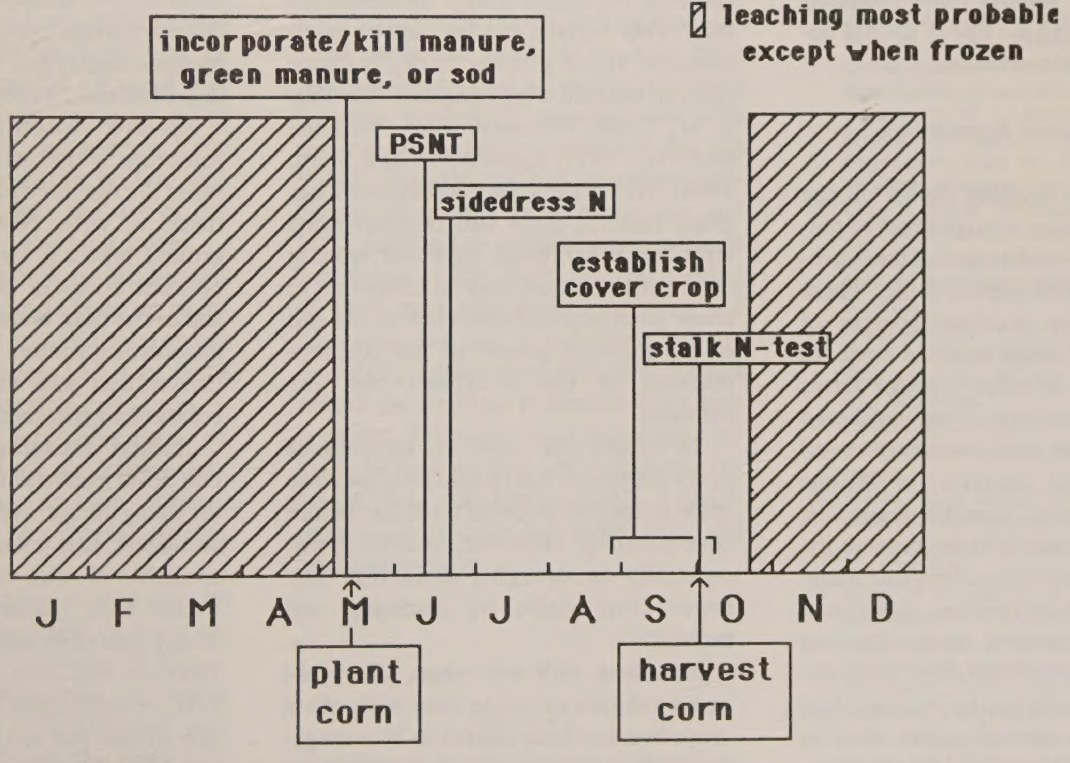
leaching most probable except when frozen
incorporate/kill manure, green manure, or sod
PSNT
sidedress N
establish cover crop
stalk N-test
J F M A M J J A S O N D
plant corn
harvest corn

Figure 1. Timing for N management practices.

The pre-sidedress nitrate test for N availability

The pre-sidedress nitrate test (PSNT) (also called the Magdoff N test, the mid-June nitrate test, and the late spring nitrate test) has been shown to be useful in evaluating N availability for corn in the humid regions of the Northeast and Midwest (Magdoff et al., 1984; Magdoff et al., 1990; Fox et al., 1989; and Blackmer et al., 1989). It is being used to make N fertilizer recommendations in Connecticut, Iowa, Maine, Pennsylvania, and Vermont, and is under evaluation in several other states in the region. The test involves determining NO_3-N in the surface 30 cm of soil when corn is 20 to 30 cm tall. Using the PSNT to make fertilizer N recommendations has been shown to reduce the recommended amount of N compared to previous recommendation systems based on the estimated effects of crop and manure management practices (Magdoff et al., 1984). On-farm studies have indicated that recommendations based on the PSNT could result in a one-third decrease in fertilizer N use in Iowa (Swoboda, 1990). Because fertilizer application rates that exceed the needs of the crop greatly increase the potential for ground water pollution with NO_3-N, using the PSNT should decrease water contamination.

Using farm-based N sources

The use of N sources grown on the farm or available as a by-product of animal production makes economic, agronomic, and environmental sense. These materials can be excellent sources of available N for crops such as corn. In fact, most dairy or other livestock farms should aim to use little or no purchased N fertilizer. With extensive use of sound rotations, animal manures, or legume green manure crops, a readily mineralizable (active) N pool is maintained in the soil. Frequent additions of organic materials such as crop residues, green manures, animal manures, and multi-year sod root systems are important for maintaining soil organic matter, besides their direct influence on availability of N or other nutrients. Maintaining or building up a good supply of organic matter, both active (easily decomposable) and well-decomposed humus, should be an integral part of all cropping systems. The importance of organic matter for crop production cannot be overstated. Good organic matter management helps improve or maintain soil structure, thereby aiding water storage, drainage, and root penetration. It also improves chemical aspects of soil fertility by providing greater cation exchange capacity to retain nutrient cations, by chelating micronutrients to keep them available, and by buffering soil pH against rapid changes. Finally, soils regularly supplied with fresh organic matter maintain a large and diverse population of organisms, which results in fewer problems with plant diseases and insects.

Legume green manure crops. Growing leguminous cover crops to provide some or all of the nitrogen needs of the succeeding crop is an old practice (Allison, 1973) that is gaining new attention (Smith et al., 1987; Power, 1987; Frye et al., 1988). The major questions when using green manure crops are the following: which species to use; how and when to establish the crop; and when to kill the crop. Hairy vetch establishes easily, is winter hardy, and produces higher yields in the region under consideration than other legume species used as green manures. It can provide 100 kg N/ha or more to the following corn crop (Ebelhar et al., 1984; Flannery, 1981; Mitchell and Teel, 1977; Sarrantonio and Scott, 1988). Where the growing season is long, green manure crops can be established after corn is harvested. However, seeding before corn harvest may be important to allow good establishment before the end of the growing season in the northern portions of the Northeast and the Midwest.

To supply the most N, leguminous green manure crops should be allowed to grow as long as possible until just before corn planting. However, in drier areas, especially on droughty soils, this may lower corn yields by depleting soil moisture.

Rotations with sod crops. There are many reasons to rotate corn with other crops besides those related to N management. Corn grown in rotation with other crops commonly yields more than when grown in a monoculture, even when is in plentiful supply (for example, Baldock et al., 1981, and discussion Voss and Shrader, 1984). This "rotati effect" has several possible causes: bet soil physical conditions, which result better drainage and water storage; fev disease, insect, and weed problems; l soil erosion; and chemical or biologi enhancement of soil fertility. Growi corn in rotation with sod eliminates need for corn root worm insecticide.

Growing a diversity of crops can a distribute the workload and decre risks associated with variability weather and markets. The nitrogen c tribution from rotations may also be s stantial. Following three years of alfa first year corn can obtain enough N produce about 9 tons dry weight gra ha and have a total harvested N upt of about 194 kg N/ha (Fox and Piek lek, 1988). Three years of alfalfa was e mated to provide the equivalent of 1 36, and 16 kg of N fertilizer per ha first, second, and third year corn resp tively, compared to continuous co Other estimates for the N contributi to first year corn following multi-y alfalfa are 70 to 84 kg/ha (Baldock al., 1981) to over 150 kg/ha (Voss a Shrader, 1984). The N contributions other legumes, such as red clover, m be significantly less than for alfalfa (F and Piekielek, 1988).

Another reason to rotate corn w sod crops is that, the less often corn pears in the rotation, the less probl there is with NO_3^- leaching to ground water (Olsen et al., 1970). S concentrations of NO_3^- are lower un sod crops than under corn. Also, grea evapotranspiration with sod cr causes drier soils and therefore less p colation to the ground water.

Animal manures. Animal manu can be an important source of N for c on many farms. As with commercia fertilizers, it is possible to add too m available N with manures, resulting excess NO_3^- leaching to ground wa Many manures have high levels of monium and urea, which lead to la NH_3 volatilization losses when manu are left on the soil surface, even if c for a few days (Lauer et al., 1976). F management of manures includes c

servative application rates, rapid incorporation, and the pre-sidedress N soil test. Subsurface injection of liquid manure (Klausner and Guest, 1981) or rapid incorporation of surface applied manures are necessary to gain the full nitrogen value for the crop. When the pre-sidedress N soil test is used, it is possible to apply manure at conservative rates (at or just under the amount believed needed to supply enough N to the crop) and then identifying any possible undersupply of N by using the soil test and making up a deficit with a sidedress fertilizer application.

Cover crops for profile NO_3^- depletion

There is interest in the practice of growing a cover crop to decrease profile NO_3^- levels before or during the time when significant leaching losses are most probable. These crops should either overwinter to continue NO_3^- uptake in the early spring or rapidly deplete profile NO_3^- in the next fall and store the N in vegetation until the next growing season. There is some evidence that the use of rye cover crops may result in lower NO_3^- concentrations in ground water (Meisinger and Shipley, 1989). Experiments with wheat, rye, or barley indicate that from about 10 to 70 kg N/ha may be removed from the profile (Wagger and Mengel, 1988); but in northern areas much of the growth, and therefore the removal of NO_3^- from the profile, will occur in the spring near the end of the period of most likely leaching losses.

The cover crop should be established early enough to maximize biomass accumulation before the end of the growing season. In northern areas this may mean seeding into the maturing corn crop in late August or early September by air or with equipment that allows driving over the field without causing crop damage, such as a "highboy" or a detasseling machine.

Early killing of the cover crop may be necessary to avoid depletion of water on droughty soils in dry areas and N immobilization from incorporating vegetation with relatively high C/N (Wagger and Mengel, 1988). Although the early killing would occur towards the end of the period of greatest leaching, it might reduce the effectiveness of cover crops for reducing NO_3^- leaching to ground water.

Traditional cover crops, such as cereals, other grasses, and common legumes, are being evaluated for their ability to decrease profile NO_3^- after corn. Nontraditional cover crops, such as some brassicas, also need to be evaluated in the future.

End of season stalk NO_3-N test

The recent finding that the NO_3^- content of the lower stalk at physiological maturity is related to whether or not excess N was present during the growing season (Binford et al., 1990) provides an additional tool for N management in corn. If stalk NO_3-N is above the critical value of about 2g/kg, the N fertilizer rate was above the economic optimum. Although this test comes after the fact, its incorporation into a management program, even if not done every year on every field, will be useful in fine tuning N application rates.

Conclusions

The possibility of significant NO_3^- pollution of ground water is inherent in growing corn. However, several management tools are available to help limit NO_3^- leaching and to reduce the need for using synthetic N manufactured with non-renewable energy sources. Using the PSNT offers the greatest immediate benefit in decreasing N fertilizer use and NO_3^- leaching to ground water without sacrificing yields. Reducing the number of years corn appears in a rotation and increasing the use of sod crops will reduce NO_3^- pollution of ground water and reduce the fertilizer N needed when corn is grown. Although using farm-based organic N sources does not necessarily decrease NO_3^- pollution potential, it makes sense economically, agronomically, and environmentally.

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Pioneer Hi-Bred develops pesticide-free Better Life Grains

Pioneer Hi-Bred International, the world's largest seed company, has developed Better Life Grains, grown without the application of chemical pesticides. Part of the Iowa-based company's Specialty Plant Products Division, the Better Life program contracts with farmers who agree not to apply fungicides, herbicides, or insecticides to the crop or soil. Chemicals cannot be applied to grain in storage; the farmer must also sign a certificate stating he has not applied chemical pesticides.

In addition, an independent testing laboratory conducts a Multiple Residue Medium scan on grain samples from each grower at harvest and/or prior to transporting, to detect any pesticide residues. Pioneer Hi-Bred certifies to the buyer that no pesticide residues were found above federal tolerance levels.

Pioneer Hi-Bred has had no trouble in getting farmers interested in the program for several reasons, it says. "Farmers have expressed a desire to reduce pesticide use to address the concerns of consumers and to demonstrate environmental stewardship," according to the company. Also, "premiums for growers of Better Life Grains are even higher than those for other 'identity preserved' grains. While farmers will save input costs for pesticides, they will incur additional costs for increased tillage, scouting, and special handling of the grain during and after the harvest. Our price premium rewards farmers well for those extra efforts."

Study finds economic advantages in reduced chemical use

If half the chemicals now applied to crops were replaced by alternative agricultural methods, yields would not decline, and food prices would rise less than 1 percent, according to a study by Cornell University researchers Dr. David Pimentel and colleagues. They also found that the benefits of reduced chemical use would include nationwide savings of $4 billion to $10 billion per year in decreased damage to fish and water supplies, decreased costs of pesticide regulation, and decreased health care costs for the 20,000 people a year who are poisoned by pesticides.

Dr. Pimentel and his colleagues advocate a return to practices that can increase yields while decreasing pesticide use, including rotating cash crops to prevent a buildup of destructive pests, "scouting" systems for early detection of pest problems, and analyses of weather forecasts to help farmers predict more precisely when chemical treatments are necessary. The study, which is the first comprehensive cost-benefit analysis of pesticide use, has been published in *Handbook on Pest Management in Agriculture* from CRC Press, Boca Raton, Florida.

Raised field agriculture in Tlaxcala, Mexico: An ecosystem perspective on maintenance of soil fertility

Timothy E. Crews and Stephen R. Gliessman

Abstract. *Raised field agriculture in southwest Tlaxcala, Mexico, is a sophisticated, intensive traditional system of wetland cultivation that dates back to as early as 300 B.C. It provides an exceptional example of how farming practices can fit into and even take advantage of ecosystem processes. The raised fields appear to be largely self-reliant in energy and nutrients. Tlaxcalan farmers use canals, aquatic plants, polycultures, alder (*Alnus firmifolia*) and other trees to intensify the nutrient input into their fields and minimize nutrient losses through leaching and runoff. Although the raised field system is an impressive, functioning example of a historically sustainable farming system, it is endangered by modern pressures to increase production through higher use of inputs and alteration of agroecosystem design.*

Key words: agroecology, nutrient cycling, traditional farming, raised field, *Alnus firmifolia*

Historical and Ecological background

Significance of raised field agriculture

Food production in most developed countries has become fundamentally dependent on fossil energy (Pimentel, 1984). A similar dependence continues to increase in the developing world. In Mexico, per capita fertilizer consumption increased from 6.6 kg/year to 28.0 kg/year between 1961 and 1986 (FAO, 1979, 1989). Synthetic fertilizers are generally the most energy intensive input in agricultural production, accounting for approximately 68 percent of on-farm commercial energy use in lesser developed countries (Mudahar and Hignett, 1987). Reliance on synthetic fertilizers allows a population to grow beyond the natural carrying capacity of a region. Increase in its per capita fertilizer use over the past forty years parallels the increase in Mexico's population (Figure 1). Although widespread use of fertilizers may have the desirable short-term effect of curbing hunger, we think that dependence on finite energy and mineral resources to maintain high levels of food production is a very unstable strategy for feeding people over the long term.

By studying the ecological and cultural aspects of traditional farming systems that, like Tlaxcalan raised field agriculture, have shown they can endure, invaluable insight can be gained into how local resources can be managed to maintain soil fertility. Such insight can be applied both in the struggle to preserve these relatively sustainable farming systems and in the design of agroecosystems elsewhere.

Historically, relatively few studies that have focused on the maintenance of soil fertility have examined nutrient dynamics beyond the farm borders. In this study we are taking a broader approach by identifying the ways in which farm management practices interact with ecosystem processes. We propose that this interaction ultimately sets the limits on sustainable production in systems where nutrients are limiting and no synthetic fertilizers are applied. Using the Basin of Puebla watershed as the ecosystem to be considered, we identify nutrient inputs into the agroecosystem, nutrient pools locked up or cycling within the agroecosystem, and nutrient outputs leaving the agroecosystem.

Construction and use of the raised fields

Raised fields are farming platforms located in regions characterized by high water tables or seasonal inundation. The fields of southwest Tlaxcala vary in size from 15 to 30 meters in width and 150 to 200 meters in length. These long narrow strips are surrounded on all four sides by "zanjas" or drainage canals (Figure 2); often the northern canals contain water only periodically because they are slightly higher than the other canals.

The construction of raised fields involves excavation of a matrix of canals over an entire farming region. The excavated soil is piled on the land between the canals to form elevated farming platforms. The canal's banks are then planted with various tree species, particularly *Alnus firmifolia* (see Figure 3).

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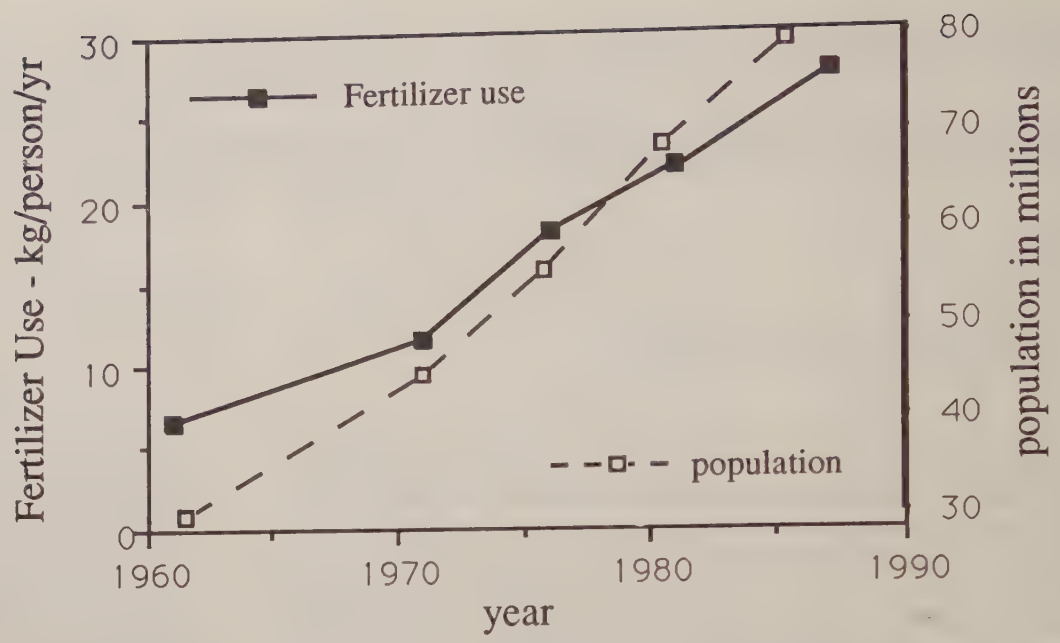

Figure 1. Increase in population and per capita fertilizer use in Mexico from 1961-1987. (Sources: FAO, 1979, 1989; Ross, 1982; Cancellier, 1985).

There is some debate regarding the most appropriate English term for this farming system. Presently, "drained field" seems to be most accepted (Darch, 1983). We and others believe that the term "drained field" falls short of describing the multi-functional nature of the canal network. The canals serve not only to drain the cultivated areas of excess water during the rainy season, but also to maintain a relatively high water table throughout the dry season for subterranean water availability and pumped irrigation. As discussed later, the canal network serves not only in hydrological management, but also as a nutrient catchment system. "Raised field" is not a perfect term either, since it only slightly connotes anything to do with water table management. At least it does not misrepresent the nature of this unique farming system.

Previous studies

The agroecology of the raised fields of Tlaxcala was first described by Wilken (1969) and is discussed further in Wilken (1987). Gliessman (1990) also briefly describes the raised fields of Tlaxcala and uses this as one example of a sustainable agroecosystem in the tropics. In a very thorough description of the agroecosystems of southwestern Tlaxcala, Gonzalez Jácome (1986) describes the important role played by raised field agroecosystems in the local economy. Anaya et al. (1987) published results from experiments on crop and non-crop allelopathic plants in the Tlaxcalan raised field flora and the effect of an array of cropping patterns on nodulation of *Rhizobium phaseolii*. Werner (1988) has written a thoroughly researched book on the pedogenesis and human alteration of the soils of Tlaxcala. A team of German soil and social scientists (including Werner) has produced a series of publications entitled *Communications, Proyecto Puebla-Tlaxcala,* which covers many topics relating to the natural and cultural history of Tlaxcala. Mountjoy and Gliessman (1988) described the terraced, upland counterpart to the raised fields of southwest Tlaxcala. This literature has described many of the on-site management practices of the Tlaxcalan farmers and the socioeconomic pressures that people of this region are experiencing because of its close proximity to Mexico City (Figure 4).

History of Tlaxcalan raised fields

Evidence of raised field agriculture has been discovered in many locations throughout Central and South America. Remnants of raised fields that date back to as early as 2000 B.C. have been found in the Guayas Basin of Ecuador (Denevan and Mathewson, 1983). The development and presence of raised field agriculture correlates repeatedly with the increase in population density and urbanization of past societies (Siemens 1990; Netting, 1974).

Based on a survey of the literature, Abascal and Garcia-Cook (1975) as well as Werner (1988) contend that indigenous people of Tlaxcala constructed a system of farming platforms similar to raised fields in the classic period, between 300 B.C. and 100 A.D. Then, from roughly 100 A.D. to 1000 A.D., lowland agriculture apparently was largely replaced by intensive terracing systems in the hills (Mountjoy and Gliessman 1988). After 1000 A.D. it is thought that the Pinome Indians, who included the Olmecs, Xicalancas, and Zacatecans once again began to cultivate raised fields in the valley floor (Abascal and Garcia-Cook, 1975).

Cook and Simpson (1948) estimated that, when the Spanish arrived in Tlaxcala in 1519, the population of the region was between 600,000 and 700,000. Gibson (1952) and Werner (1988) considered this first estimate to be high and

Figure 2. Cross-section of a raised field.

recalculated Tlaxcala's fifteenth century population at between 200,000 and 300,000. In 1980, the total population of the modern state (similar in size to the Prehispanic region) was approximately 556,500 (Secretaria de Agricultura y Recursos Hidráulicos, 1982a). Although the fifteenth century population density of Tlaxcala was lower than that of today, it ranks higher than the modern population density of 26 of the 32 Mexican states (Garcia de Miranda and Falcón de Gyves, 1986). It is thought that the intensive farming of raised fields played a critical role in feeding Tlaxcalans of five centuries ago (Werner, 1988).

Geologic and climatic setting of the raised field agroecosystem

The Basin of Puebla in southwest Tlaxcala is cradled on both its eastern and western sides by massive volcanos. To the east stands La Malinche at 4461 meters, and to the west tower Iztaccihuatl, at 5146 meters, and Popocatepetl, at 5452 meters. The valley floor of the basin where the raised fields are found lies at 2100 meters. These three volcanos help mark the trail of the Neovolcanic Cordillera, which lies approximately along the 19th parallel between the Pacific and the Atlantic. Volcanic activity in the Miocene (25 to 10 million years ago) began to sculpture the landscape of modern day Tlaxcala, and this process continued through the Pleistocene (600,000-12,000 years ago) (Werner, 1988). The chemical and physical weathering of these geologic formations have formed the young soils of Tlaxcala today. The raised field region of southwest Tlaxcala received considerable alluvial deposition in the Holocene by the Zahuapan and Atoyac Rivers (Werner, 1988). The occasional smoke that rises from the distinct cone of Popocatepetl is a reminder that tectonic activity is still present in the region.

Although Tlaxcala is situated well below the Tropic of Cancer, its high altitude and mountainous terrain give it a subhumid temperate climate, very similar to that of Mexico City. Tlaxcala's climate is rainy temperate with seasonal rains in the summer and dry in the winter. An average of 800-1000 mm of rain fall on southwest Tlaxcala every year, 95 percent of which occurs between April and October (Secretaria de Agricultura y Recursos Hidráulicos, 1982b). Average annual temperature in the region is 15.8 C, with a low monthly average of 14.0 in January and a high monthly average of 19.5 in May (Garcia, 1973).

Nutrient inputs

In most watersheds, previously unavailable nutrients are introduced to the biota in three basic ways: 1) through weathering of primary and secondary minerals of parent rock and soil; 2) through atmospheric deposition of both precipitation (wetfall) and dust (dryfall);

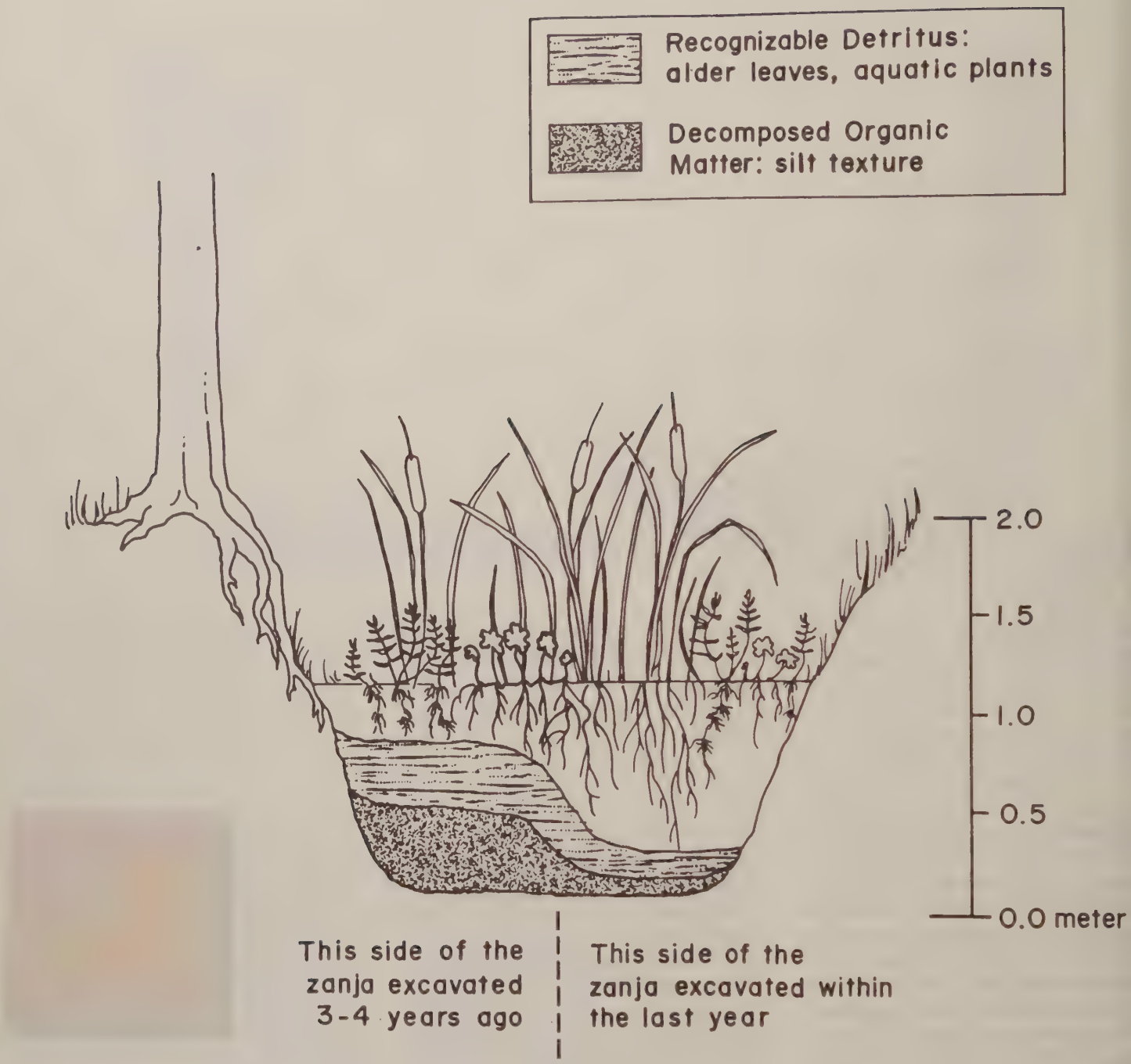
Recognizable Detritus: alder leaves, aquatic plants
Decomposed Organic Matter: silt texture
2.0
1.5
1.0
0.5
0.0 meter
This side of the zanja excavated 3-4 years ago
This side of the zanja excavated within the last year

Figure 3. Cross-section of a Zanja.

and 3) through symbiotic or free living nitrogen fixing organisms (Trudgill, 1988; Gorham et al., 1979). These three sources of nutrients are what the Tlaxcalan farmers have to work with to balance the nutrient outputs from their farms (Table 1).

Nutrient inputs from weathering of parent material and soil

Weathering of relatively young primary and secondary minerals comprises a significant input of previously unavilable nutrients into natural terrestrial ecosystems as well as agroecosystems that do not receive applications of synthetic fertilizers. Depending on the nature of the minerals, and the weathering agents affecting the soil system, such as temperature, moisture, plant roots, and organic acids, mineral weathering can incre the availability of P, K, Ca, S, Mg, M B, Fe, Zn, Mo, Co, Cl, and Cu to biota (Clayton, 1979).

An unknown fraction of the nutri inputs in the Basin of Puebla watersh are leached or eroded from the slopes the 4400-5400 m volcanos surround the raised field region and deposited the valley waterways. In this way nu

Figure 4. Tlaxcala in relation to Mexico.

ents from a massive watershed are concentrated in the valley floor, where they are "trapped" for use in agriculture. The extent to which this concentrating effect directly fertilizes the raised field district would be difficult to show. However, extensive erosion on the surrounding hills and mountains is clear evidence of mass translocation of topsoil to the basin floor.

Nutrient inputs from atmospheric deposition

A substantial pool of nutrients is maintained in the atmosphere in gaseous form (N and S) and particulate form (K, Mg, Ca, etc.). These nutrients enter the atmosphere by way of volcanic erup-

Table 1. Classification Scheme for Nutrient Fluxes in a Raised Field Agroecosystem.

NUTRIENT INPUTS—where nutrients are introduced into a biota of which they were previously not a part
weathering of primary minerals (parent rock) and secondary minerals (silicate-clay minerals, iron and aluminium oxides, etc.)
atmospheric deposition of dryfall (dust) and wetfall (precipitation)
biological nitrogen fixation (alfalfa, beans, alder trees, possibly cyanobacteria)
NUTRIENT CYCLING—where nutrients are either cycled or stored within the agroecosystem
canal aquatic plants and wild terrestrial herbs
canal border tree species
canal muck
crop residues
soil organic matter and detrital organisms
manure of domesticated animals
NUTRIENT OUTPUTS—where nutrients leave the biotic nutrient cycling of the agroecosystem
leaching and runoff from the raised fields
harvests for human consumption
denitrification and leaching of animal manures

tions, dust, pollution, and anoxic soil or water bodies (Likens et al., 1977). The quantity of nutrients entering the Basin of Puebla through atmospheric deposition from human made sources alone is likely to be considerable. The city of Puebla, which boasts a population of 2 million and well-developed industries, and is only 30 km away, undoubtedly increases the amount of NO_3^- and NH_4^+ as well as various sulfur compounds entering the raised field watershed in rainfall. Small quantities of atmospheric N_2 that are oxidized to NO_3^- during lightning storms also enter the watershed through rainfall (Gorham et al., 1979).

Nutrient input from biological nitrogen fixation

Nitrogen fixation can be considered an atmospheric input, but because it is a biological process involving either free living prokaryotes or prokaryotes living in symbioses with plant species, we treat it separately from the abiotic atmospheric nutrient inputs discussed above. The degree to which Tlaxcalan farmers have integrated N fixation into their agroecosystem is impressive. We found that legumes comprise 10-30 percent of the total cropping surface of the typical raised field. Two common new world bean species, *Phaseolus vulgaris* and *P. coccineus*, are planted extensively. *P. coccineus*, a climbing bean, is intercropped with corn and squash in the classic Mesoamerican polyculture, while *P. vulgaris*, a bush bean, is planted in rows by itself. *Vicia faba*, an old world legume and vigorous N-fixer, is grown extensively in the winter alongside or intercropped in patches of oats.

The contribution that these crop legumes make to the overall N budget of this farming system should not be overemphasized. It is possible, especially in the case of *P. coccineus*, that the relatively high concentration of soil N maintained by the farmer in the corn/bean/squash rhizosphere is high enough to suppress N fixation in the bean species. Where N fixation is not suppressed, the symbionts will provide some or all of the N required by these crops. At harvest, however, as much as 80 percent of the bean plant N is removed from the farming system in the bean (Gliessman, 1982) and is not recycled to the soil in any way.

The crop that more likely contributes large quantities of N to the raised field agroecosystem is alfalfa (*Medicago sativa*). Depending on growing conditions, alfalfa has been shown to fix between 30-300 kg/ha/yr (LaRue and Patterson, 1981; Heichel, 1987). The typical raised field plot has a strip of alfalfa, approximately three meters wide, running between half to full length of the field, depending on how many animals the farmer needs to feed. Farmers harvest from a single planting of alfalfa for two to five years, with three the most common. When a planting no longer yields well, the old strip is plowed under and planted in a non-legume crop, usually corn, while a new alfalfa strip is sowed alongside the old. In this manner, the alfalfa strip makes a complete rotation across the farming plot an average of every fifteen to twenty years. Nitrogen and other nutrients in the alfalfa are constantly removed from the raised field as fodder, but because animal manure is returned to the farming plot, N fixed by the alfalfa/*Rhizobium* symbiosis is considered a net input into the raised field agroecosystem.

Nitrogen enters the raised field agroecosystem through non-crop fixation as well. Many species of trees are planted on the margins of the raised fields alongside the canals. These trees range from non-crop species like *Buddleia* sp. and *Salix bonplandiana* to crop species such as *Prunus capuli* (capulin) and *Juglans* sp. (walnut). By far the most ubiquitous tree species bordering the raised fields is the alder, *Alnus firmifolia*. The alder maintains a symbiosis not with a rhizobium bacterium, but with a nitrogen-fixing actinomycete, *Frankia* sp. Nitrogen from the alder trees is made available to the crop plants through N rich leaves that fall directly on the fields or into the canals. The leaves of *Alnus firmifolia* in Tlaxcala were found to contain 4-5 percent nitrogen before leaf fall (Gliessman, unpublished data). The amount of N that may be retranslocated from the leaves before senescence is undetermined.

Nutrient exports

Although the total nutrient input in the raised field ecosystem appears hi for a natural terrestrial ecosystem, does not approach the concentration nutrients applied as synthetic fertiliz in conventional modern farming sy tems. This is especially true for N.

Undisturbed forested ecosystems l nutrients in three general ways: throu surface runoff, subsurface leaching, a denitrification. In annual agricultu where the soil is plowed regularly a fields are denuded of vegetation at le once a year, leaching and runoff are ge erally greatly exacerbated (Woo mansee, 1984). In addition to nutrie loss via pathways that occur in und turbed forested ecosystems, agroecos tems lose nutrients through the export harvested materials. Using corn nutrie values from Delwiche (1971), a two m ric ton harvest of corn, which is a go harvest from a 3/4 ha raised field, co tains approximately 26 kg N, 5 kg P kg K, 2.5 kg S, 4 kg Mg, and 2.5 kg in the seed alone. Beans, squash, fru and other plants also are harvested fro the raised field plots.

Corn stover and alfalfa are fed to a mals that are kept in pens away from t fields, and the manure from the anim is hauled back to the fields and appli before maize or alfalfa is sowed. T process can largely be considered a c cling of nutrients. However, many m nure piles are exposed to rainfall a thus lose nutrients via leaching and de trification. Based on numerous int views with farmers and personal obs vation, we believe that nightsoil human manure is not returned to t raised field agroecosystem.

Even with appreciable nutrient ports occurring from the raised fiel we found excellent soil fertility in th plots that have never received appli tions of synthetic fertilizers (Table On an ecosystem scale, how have Tlaxcalan farmers managed to balan the nutrient exports from their syste leaching, runoff, human food harves and denitrification of manure piles--w the baseline nutrient flux entering th watershed via weathering of primary a secondary minerals, atmospheric depo

Table 2. Soil Nutrient Status of Corn/Bean/Squash and Alfalfa Plots in Raised Fields, Santa Ines Tecoexcomac, Tlaxcala, Mexico.

Soil depth (cm)	% Organic C[1]	% Total N[2]	Avail P[3] (μg/gdw)	Avail K[4] (μg/gdw)
Corn/Bean/Squash Polycultures				
0-15	1.3 (0.17)	0.17 (0.02)	63 (20)	871 (253)
15-30	1.2 (0.05)	0.16 (0.01)	52 (16)	892 (209)
Alfalfa				
0-15	1.5 (0.03)	0.20 (0.02)	67 (4)	765 (53)
15-30	1.0 (0.18)	0.14 (0.01)	38 (5)	742 (21)
Soil nutrient ranges reported in the literature using similar analytical procedures				
	0.08-1.90[5]	0.008-.247[5]	0.8-145.0[6]	16-1060[7]

( ) = SD, n=3;[1] Modified Walker-Black; [2]Dumas-dry oxidation; [3]Sodium bicarbonate extraction; [4]Ammonium acetate extraction; [5]Sanchez et al. (1982), n=106; [6]Balerdi F. et al. (1968), n=104; [7]Kovar and Barber (1990), n=33.

tion, and nitrogen fixation? The answer appears to lie in the canals.

The canals that border the raised fields are covered with dense populations of macrophytes, including *Sium angustifolium*, *Lemna* sp. (duckweed), *Hydrocotyle ranuculoides*, *Typha angustifolia* (cattail), *Cyperus* sp. and *Scirpus* sp. The robust aquatic vegetation takes up nutrients from the water and sediments from spring through autumn. Much of this vegetation dies back in the fall and sinks to the bottom of the canal. The canal also receives sediments eroded from the raised fields and leaves from the herbaceous and tree vegetation bordering the canals (including alder).

Farmers undertake the arduous task of cleaning up to one vertical meter of muck and aquatic plant vegetation out of the canals bordering their fields every one to four years. The excavated muck and vegetation is spread on the raised fields. We calculated that, when a farmer excavates the muck from the canals surrounding an average raised field, he adds approximately 1080 kg total N per hectare, as well as 120 kg K (ammonium acetate extractable) and 9.7 kg P (sodium bicarbonate extractable) per hectare to the farming platform. On an ecosystem level, applying excavated muck to the fields greatly reduces the loss of nutrients to leaching and erosion from the raised field region. One can think of the farmers as diverting nutrients that leave agroecosystems in leaching and runoff to food harvests.

Policy context of raised field agriculture

In the last decades, Mexico has developed a three-part program to assist farmers in modernizing their farms. The program consists of a rural credit agency, Banrural, which makes short-term loans to groups of farmers to buy hybrid seed and fertilizers and other agrochemicals. Banrural also makes long-term loans for tractors, land, and other investments. Also, the government established Fertimex, an agrochemical industry that provides inexpensive fertilizers for farmers to buy with their loans. Finally, the government guarantees crop prices at the start of each farming season.

Although the government's push to modernize agriculture in southwest Tlaxcala has led most farmers to begin to use at least small applications of synthetic fertilizers and to a lesser extent pesticides and hybrid seeds, several region-specific hurdles have prevented full adoption of modern farming techniques. The first hurdle is the small size of farms in the raised field region. After the Mexican Revolution of 1910, land reform programs under Presidents Obregón, Calles, and Cárdenas turned over the property of many large landholders to peasant communities (Cumberland, 1968). These community holdings were called "ejidos." Ejido land was generally partitioned among the families of the community. To prevent accumulation of large landholdings, the sale and purchase of land was prohibited. About half of Tlaxcala's arable land is ejido, including almost all raised field land. Ejido farmers can expand their plot size in two ways: they can rent a neighbor's plot, or they can collectivize farm management with other farmers. Renting land is more common in the raised field area, but neither is very widespread.

The second hurdle slowing modernization of the raised field area is the physical character of the raised fields themselves. The presence of canals, a relatively high water table, rows of trees, and strips of alfalfa amidst the corn, beans, and squash, make raised fields very unattractive for large- or medium-scale mechanized production. Without larger-scale commercial production, it appears that the farmers cannot afford to use high levels of inputs. To increase the scale of operation in the raised field area, the water table would need to be lowered, which would involve filling in the canals, cutting down the alders, and either collectivizing the farms or further establishment of rent tenure. Samiro Casares, agricultural engineer for the Secretaria de Agricultura y Recursos Hidráulicos of Tlaxcala, said in an interview that to convert the Santa Ines raised field area into valuable farmland would require a major drainage project. If such a project is carried out in the raised field region, as has been accomplished to varying degrees in other parts of Tlaxcala, the ecological and managerial complexity and sustainability of this unique agroecosystem would be greatly reduced.

Conclusion

Raised field agriculture in Tlaxcala, Mexico, provides an unusual example of how an intensive cropping system can be productive over time without depending on synthetic fertilizers, even when considerable quantities of nutrients in food are permanently removed from the farm at harvest every year. An informative next step in researching this traditional agroecosystem will be to measure the baseline nutrient flux of the raised fields and their surrounding watershed to ascertain which sources of nutrients are most important, such as alder trees, alfalfa, atmospheric deposition, and mineral weathering, and which nutrients are limiting overall productivity of the farms.

With Mexico continuing to be a net importer of the staple crop maize, eco-

nomic policy continues to be structured towards the reasonable goal of maximizing production (Austin and Esteva, 1987). As in many other parts of the world, there is a profound tension between immediate human needs and longer-term ecological and cultural sustainability. Mexican farmers are under pressure to increase their use of energy-intensive inputs to produce more food, as well as increase the scale of their farming systems. The intention of our research, besides documenting a unique agroecosystem, is to understand what works in these farms from an ecological and managerial point of view. We suggest that improvement or modification of what already works, rather than wholesale replacement of one farming approach by another, is the best way to increase sustainable productivity from this enduring agroecosystem.

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Institutional support for practicing sustainable agriculture

Peter F. Korsching and James E. Malia

Abstract. *A mail survey of Iowa farmers with membership in the Practical Farmers of Iowa, a sustainable agriculture organization, was used to examine perceptions of institutional support for information on reducing chemical inputs, needed research for farming with sustainable practices, and policy needs for encouraging farmers to adopt sustainable practices. We first developed a chemical input index to measure commitment to sustainable practices and to analyze information sources and research and policy needs. Results indicate that sustainable farmers rely primarily on each other and on their personal experience for information about sustainable practices; they use conventional farm practice information sources considerably less. The primary research need identified by the respondents was for better nonchemical weed control. Other important research needs identified were: nonchemical insect control, new seed varieties, cover crops, alternative tillage methods, and the economics of sustainable systems. The primary policy needs identified were more information and educational programs about sustainable agriculture and increased taxes on farm chemical use. We discuss the implications of the relationship between institutional support and the adoption of sustainable agriculture practices.*

Key words: sustainable agriculture, institutional support, chemical inputs, information sources, research needs, policy options

Introduction

An increasing number of farmers are adopting alternative farming systems with technologies and management practices that reduce the problems and costs of conventional production systems. An alternative farming system commonly called sustainable agriculture is currently drawing broad interest. Agribusiness firms on both the input and marketing sides are concerned about the impacts of widespread adoption of sustainable agriculture, particularly if sustainable also means low-input agriculture. The research and extension arms of the land grant institutions, along with their federal partner, the U.S. Department of Agriculture, are developing programs and allocating resources in support of sustainable agriculture. Policymakers at the federal and state levels are searching for guidance in developing policies that would capture the benefits of sustainable agriculture with minimum disruption of existing economic, social, and institutional systems (Benbrook, 1988; Myers, 1988; Iowa Groundwater Protection Act, 1987).

The goals of sustainable agriculture are to return a profit, decrease harm to the environment and to personal health, and provide a basis for a sustainable community by offering a way for people to stay on the land and be less dependent on federal payments for their livelihood (Lockeretz, 1988). These goals of sustainable agriculture and the needs of farmers using sustainable systems are not being met by research and information programs and farm policies that emphasize specialization, intensive production, and the extensive use of chemicals (Andrew, 1987; Blobaum, 1983). Federal funds to conduct research and extension programs in low-input sustainable agriculture are less than one percent of the total public expenditure on agricultural research. As Ikerd (1989) states, "...public agricultural research and extension work over the past three decades...has been to increase productivity and profitability through greater reliance on purchased inputs."

Eligibility requirements and subsidy incentives of federal farm support programs undermine the broad potential for adoption of sustainable agriculture. These programs discourage farmers from reducing agrichemical use by putting constraints on use of multiyear crop rotations and alternative "nonprogram" crops (Fleming, 1987). To maintain eligibility for support payments, farmers must plant at least half their base acreage each year to crops covered by the support program. The programs also encourage more intensive production with chemicals by raising the "break even point" for chemical application (Fleming, 1987).

The importance of institutional support for continued diffusion of sustainable agriculture should not be discounted. Research on the adoption of practices in one dimension of sustainable agriculture, soil conservation, has shown that institutional support such as education and technical assistance programs is very important (Korsching, 1984). Additionally, Crosson and Ostrov (1988) suggest that alternative agriculture, whether "low-input," "regenerative," or

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"organic" agriculture, generally is less profitable to farmers than the conventional systems, in part, because of the government subsidized prices for conventionally grown crops (Goldstein and Young, 1987).

This paper examines farmers' perceptions of three kinds of institutional support: information for reducing chemical inputs, policies to encourage farmers to adopt sustainable practices, and needed research for farming with sustainable practices. Although there are many terms for this mode of production, we adopted sustainable agriculture for use in our study because it is familiar to the farmers in the sample. We surveyed the membership of the Practical Farmers of Iowa to determine the research and policy needs of practicing sustainable farmers and the kinds of information and other support they need to continue using these methods.

Methods

Sample and data collection

Data were obtained through a mail survey of members of Practical Farmers of Iowa (PFI), a nonprofit organization that conducts on-farm research on environmentally sound, low-cost, profitable farming techniques. A letter from the president of PFI expressing support for the project was mailed with the questionnaire. We screened eligible farmers by asking the following questions: Whether the respondent operated a farm that produced or sold at least $1000 of agricultural products during 1988; whether the respondent grew any crops such as corn, soybeans, small grains, or vegetables; and whether any low-input sustainable practices were used on the farm, such as a reduction in agricultural chemicals, reduced tillage, or other conservation practices. A "yes" to each question was needed to be included in the final sample. Two-hundred-sixty-nine questionnaires were delivered; 195 were returned, of which 168 were usable as determined by the screening criteria.

Chemical input index

We developed a chemical input index to measure farmers' commitment to using sustainable practices. Farmers were asked to indicate the practices that they used to control weeds and insects and the sources of nitrogen that they used during the 1988 crop year. Complete, usable information on chemical inputs was given by 151 farmers, and the analysis is based on their responses.

For each practice and each source of nitrogen used, we asked on what percentage of cropland that practice or source was used. The information was used to compute a separate input score each for herbicides, insecticides, and nitrogen sources based on intensity of chemical use, with higher numbers indicating greater intensity.

The herbicides input score was computed by coding broadcast application of herbicides as 3, application by banding as 2, and spot spraying as 1. Each score was then multiplied by the percentage of cropland on which it was used. The resulting scores were summed for the herbicide input score.

The insecticide input score was computed by coding conventional soil insecticide applications as 3, leaf spraying the entire crop as 2, and spot spraying when and where needed as 1. Each score then was multiplied by the percentage of cropland on which it was used. The resulting scores were summed for the insecticide input score.

For the nitrogen input score, the two chemical sources of nitrogen, anhydrous ammonia and urea, were each coded 3. The input score for each source of nitrogen was then computed by multiplyi the source of nitrogen by the percenta of cropland for that source. The sum the individual scores yielded the che cal input score for nitrogen. The to chemical input index for each farm was then derived by summing the th separate chemical input scores. Tabl gives summary statistics of the nitrog herbicide, and insecticide input score

A distribution of the total input ind was divided into five approximat equal size categories to use as a basis analysis (Table 2). A low score indica that fewer chemical inputs are used a that there is a greater commitment using sustainable practices. We rec nize that this may not necessarily b completely accurate representation farmers' commitment to using susta able practices. Although we have inf mation on the percentage of cropland which they use chemicals, we do have information on the amount th apply, a factor that could vary great As a check on the validity of this ind we correlated the chemical input sc with the response to a question on red tion of chemical inputs. The reducti in chemical inputs was coded into categories of 1 for never used the che cal, 2 for reduced use by 100 percent for reduced use by 50-99 percent, 4 reduced use less than 50 percent, an for did not reduce use. The correlatio were .67 for herbicides, .66 for inse cides, .56 for nitrogen, and .75 for to chemical use. These correlations indic a consistency between the two measu of chemical use.

We also recognize that other fact may account for the level of chemi inputs used. For example, a farm might continue to experiment with ferent levels in an effort to find the o mum. A farmer could also be econo cally vulnerable and thus not able

Table 1. Summary Statistics for Chemical Input Scores.

	Nitrogen	Herbicides	Insecticides	Total
Mean	1.59	1.73	.41	3.73
Median	1.50	2.00	.00	3.50
Range	.00–6.00	.00–5.40	.00–4.30	.00–11.00

Table 2. Distribution of total input index.

Category	Number	Rang
1	28	.00
2	32	.15–3.
3	31	3.15–4.
4	30	4.60–6.
5	30	6.05–11

afford the risk of reduced chemical inputs. Finally, a farmer's credit or lease arrangements could limit the amount of experimentation and change possible. Despite these complications, minimal use of chemical inputs is the core of any definition of sustainable agriculture, and the total chemical input index is a relatively valid measure of commitment to sustainable farming.

Sources of information

We asked farmers how often they used several sources of information for reduced chemical input farming. Table 3 gives the frequency of responses. Responses were scored 1 for never used, 2 for sometimes used, and 3 for often used.

Research and policy needs

We asked the farmers how helpful research on several topics would be for their farming operations. Helpfulness then was scored 1 for none, 2 for little, 3 for more, and 4 for most (Table 4). They also were asked about the importance of several policy options for encouraging farmers to adopt sustainable practices. The answers were scored on the same scale as the research needs. Specific items for each question and the frequency of responses are found in Table 5.

Analysis

Each of the three components of institutional support--information, research, and policy options--will be examined. We used Spearman rank order correlations to examine the relationships between commitment to sustainable agriculture, as measured by the total chemical input index, and the three components of institutional support.

Information

Table 3 indicates that other low-input farmers are an important source of information on reduced chemical input farming. Conventional farmers, on the other hand, are not important sources of infor-

Table 3. Frequency of use of information sources by farmers for reduced chemical input farming, and Spearman rank-order correlations (r)* between information sources and total chemical input index.

Information Sources	Never Used	Sometimes Used	Often Used	r
Other low-input farmers	8	45	47	−.11
Conventional farmers	49	49	2	.20
Own experience	1	14	85	−.16
Organic/sustainable alternative farm magazines	9	43	48	−.21
Popular farm magazines	30	60	10	.34
Organic farm supply dealers or consultants	54	35	11	−.36
Conventional farm supply dealers or consultants	47	47	6	.39
County extension agents/extension specialists or their publications	34	53	13	.26

*Coefficients of ±.14 or larger are significant at .05.

Table 4. Percentage of farmers indicating degree of helpfulness of research topics for encouraging and practicing sustainable agriculture, and Spearman rank-order correlations (r)* between research topics and total chemical input index.

Research Topics	Helpfulness				
	None	Little	More	Most	r
Nonchemical weed control	1	4	34	61	−.05
Nonchemical insect control	4	13	34	49	.11
New seed varieties for sustainable practices	2	13	52	33	.06
The use of cover crops	2	14	53	31	−.16
Alternative tillage methods to improve soil tilth and productivity	1	14	50	35	.14
Integrating livestock into sustainable systems	6	19	49	26	.02
The economics of sustainable systems	3	13	52	32	.18
Growing and marketing alternative crops	4	29	43	24	−.04
Marketing of organic crops	9	27	36	28	−.28
Using herbicide resistant varieties and biopesticides with sustainable practices	16	32	38	14	.34
The use of growth hormones to increase pork or milk production	60	33	6	1	.32

*Coefficients of ±.14 or larger are significant at .05.

Table 5. Percentage of farmers indicating importance of policy options for encouraging and practicing sustainable agriculture, and Spearman rank-order correlations (r)* between policy options and total chemical input index.

Policy Options	Importance				
	None	Little	More	Most	r
Reform commodity program regulations to allow a variety of crops to be included when computing base acres	2	15	46	37	.03
Greater regulation of farming to ensure more environmentally sound practices	15	28	36	21	−.11
Low-interest loans and cost sharing for low-input operations	11	29	39	21	−.04
More information and educational programs about sustainable agriculture practices	1	10	38	51	−.04
Availability of special subsidies for farms converting to sustainable practices	14	26	35	25	−.06
Increased taxes on use of farm chemicals	10	20	27	43	−.28
"Decouple" income support for farmers from current production. Payments would be based on past production and a crop would not have to be produced to receive payments.	23	28	29	20	.14

[1] Coefficients of ±.14 or larger are significant at .05.

mation. The lack of a consistent support system for sustainable farmers is shown by the fact that the source of information used most often is the farmer's own experience. This supports the perception of sustainable farmers as innovators unwilling to accept conventional wisdom but preferring to experiment and learn from their own experiences. Also, the farmers in our sample do not often use the extension service as a source of information. The orientation of most extension programming toward maximum production is not compatible with low-input sustainable production.

The frequency of use of the sources of information in this study is significantly related to the total input index. The strongest relationships, however, are the positive relationship between total chemical input index and conventional farm supply dealers or consultants ($r = .39$) and its inverse relationship with organic farm supply dealers or consultants ($r = -.36$). Both kinds of dealers are important sources of information, but the conventional dealers and consultants are used most by farmers who use the most chemical inputs, whereas organic dealers and consultants are used most by those farmers using the least chemical inputs. Popular farm magazines are more highly correlated to the total input index than organic farm magazines, but again, the use of popular farm magazines increases with increasing chemical use, whereas the use of organic farm magazines increases with decreasing chemical use.

The source of information that the most farmers said they use often, namely their own experience, was inversely and significantly related to total chemical input, although the relationship was weak. The weak relationship between level of chemical input and reliance on low-input farmers as a current source of information ($r = -.11$) is perhaps indicative of the small number and wide dispersal of sustainable farmers in the state. The respondents in our sample came from 77 of Iowa's 99 counties, or approximately 2 per county. The largest number of sustainable farmers in any one county was 5.

The relationships between the total input index and conventional farmers and the extension service are positive. Because these sources use or support the use of farm chemicals, the higher the chemical inputs of the sustainable farmers, the more they use these sources, as would be expected.

Research

Nonchemical weed control was the research topic selected as being the most helpful to practicing sustainable agriculture, with 61 percent of the respondents ranking it in the "most helpful" category and an additional 34 percent ranking it "more helpful" (Table 4). This reflects a real need by farmers for research that traditionally has been lacking in the public institutions that support farmers and agriculture. Ineffective nonchemical weed control techniques and nonchemical insect control techniques (the latter rated as "most helpful" research by 49 percent and "more helpful" by 34 percent of the respondents) are major factors for sustainable farmers returning to conventional farming. In another question on our survey (not reported here), 45 percent of the respondents indicated that increased problems with weeds and insects would prompt them to return to, or increase their reliance on, chemical inputs.

Generally, the farmers in the survey ranked all research topics relating to nonchemical practices and tillage practices fairly high. New seed varieties, using cover crops and alternative tillage methods, integrating livestock into sustainable systems, and the economics of sustainable systems were placed in the "most" or "more helpful" categories by a combined total of 75 to 85 percent of the sustainable farmers in the survey.

The general areas of growing and marketing alternative crops and marketing of organic crops were considered somewhat less helpful, with 24 percent and 28 percent of the respondents, respectively, rating them most helpful. The third-wave topics of biotechnology research were considered least helpful. About an equal percentage of the respondents rated the use of herbicide resistant varieties and biopesticides as on the extremes of "most helpful" and "not helpful" (14 and 16 percent), and about one-third each rated them "a little helpful" and "more helpful." These farmers rec
nize, perhaps, that herbicide resistant
rieties may actually lead to greater
of herbicides. The use of growth h
mones to increase pork or milk produ
tion received the least support of
items, with only 1 percent consideri
it "most helpful" and 60 percent "
helpful." This may be a reaction by
farmers to a belief that, as in the pa
research results in high-technology are
will primarily benefit the mainstrea
producers using chemically intensi
practices.

Only six of the research topics are s
nificantly related to the total chemi
input index. Alternative tillage metho
and the economics of sustainable syste
are both positively but weakly related
the total chemical input index. The
two variables also have a moderate po
tive relationship with each other (r
.35, not shown in table) indicating a po
tive relationship between amount
chemical input and strength of the far
er's economic orientation. As expecte
marketing of organic crops and the
of cover crops research priorities are n
atively correlated with the total inp
index. Also, as expected from the dist
bution of the frequencies in Table 5,
two biotechnology research topics
positively related to the total input ind
with moderate correlations. The t
variables also are moderately and po
tively correlated with each other (r
.28, not shown in table). Again, this m
reflect an increasing perception that su
research benefits those farmers usi
practices that more closely approxima
mainstream farming.

Policy options

The two policy options seen as m
important by farmers in the sample a
are mentioned most often in the lite
ture as important (Table 5). The optic
are to provide more information and
ucational programs about sustainal
agricultural practices and to refo
commodity programs to include a va
ety of crops when computing base acr
These options were selected as be
"most important" by 51 and 37 perc
of the respondents, respectively, with
additional 38 and 46 percent, resp

tively, selecting them as "more important." Two of the policy options were regulatory, one for increasing taxes on the use of farm chemicals and the second for greater regulation of farming to ensure more environmentally sound practices. Both were perceived as important with 70 percent and 57 percent, respectively, of the farmers indicating that they were "more" or "most important." Similarly, direct financial subsidies were considered important.

The policy option that received least support was decoupling of income support for farmers from current production, with the two lowest and two highest ratings split almost evenly. There may be several explanations for this, including a work ethic among farmers that precludes the acceptance of government payment not based on productivity, especially since such decoupling is often considered a welfare program. A related explanation is the strong "farming as a way of life" orientation of sustainable farmers. For sustainable farmers to receive payment for not farming would be contrary to their self-definition and hence would be of little interest to most respondents.

Only two of the policy options were related significantly to the total chemical input index. One option was increased taxes on use of farm chemicals, with a moderately negative correlation (−.28). It is not surprising that farmers who use the most farm chemicals would be least in favor of a tax on chemicals. The other was decoupling of income support for farmers from current production, with a weak positive correlation (.14) indicating that, although there is no strong support for decoupling, there is a tendency for those more in the mainstream of farming to support decoupling. The lack of significant relationships between the other policy options and the total chemical input index probably indicates that, although these options are important to sustainable farmers, their perceived overall impact would be relatively neutral, at least for this group of sustainable farmers.

Discussion

In this paper we examined perceptions of and use of institutional support by farmers who are practicing some degree of sustainable agriculture. These farmers responded to questions on information sources for reducing chemical inputs, needed research for farming with sustainable practices, and policy needs for encouraging farmers to adopt sustainable practices. We found that all the specified information sources had some degree of importance to the farmers, but there were few significant relationships and overall relatively weak correlations between the measure of commitment to sustainable agriculture as measured by the total chemical input index and the perceived need for several research topics and policy options. This may be a consequence of the sample which is composed of sustainable farmers with a varying level of commitment to sustainable agriculture. This may have reduced the variability of the potential impacts of the dependent variables: information sources, research topics, and policy options. Therefore, even though items may be considered important, because of the nature of the sample there may be no relation to chemical use. We did, however, find variations and significant relationships for some of the items within this particular sample. With a totally random sample of farmers, we may have found additional statistically significant and greater substantively significant results. Thus, the results of this paper have important implications for addressing the needed institutional support of sustainable farmers.

The results suggest several implications about institutional support and the adoption of sustainable farming practices.

1. Farmers interested in sustainable agriculture cannot be narrowly defined, as demonstrated by our sample of farmer members from the Practical Farmers of Iowa. They all belong to an organization that promotes sustainable agriculture, yet there is a great diversity in their farm management practices. For example, some farmers use no chemical inputs, while others use relatively high amounts. Therefore, in developing programs and policies to support sustainable practices, it would be important initially to cast a wide net to be as inclusive as possible in contacting potential adopters of sustainable agriculture. Once their interest is piqued, they can receive information on practicing good sustainable agriculture to reinforce further reduction of chemical use.

2. For our sample, two major sources of information about sustainable practices were other low-input farmers and the farmer's own experiences. Although we did not pursue the reasons for using the different sources, a safe assumption based on the literature is that this is not completely by choice. The conventional information sources on farming practices, such as the extension service, are not considered to be credible information sources by sustainable farmers, or they simply do not have the information needed for sustainable farming. Therefore, sustainable farmers fend for themselves. If the extension service and other such organizations want to become important information sources on sustainable farming, they will need to expend more resources and develop strong programs in this area to gain credibility among sustainable farmers.

3. The strongest correlations between commitment to sustainable agriculture and the research topics were for the items on herbicide resistant varieties and growth hormones. Farmers using more chemical inputs were more positive about the potential benefits of these third-wave technologies. Sustainable farmers placed lowest priority on these areas of research that currently enjoy high priority in both the land grant system and the private sector. In part, this may be a concern among sustainable farmers that the development of herbicide resistant varieties will lead to increased use of herbicides, a scenario to which they are philosophically opposed and which would also place them in a further economic disadvantage.

4. There seems to be relatively strong support for increased taxes on use of farm chemicals. About 70 percent of the sample gave it one of the two highest ratings as an important policy option for encouraging and practicing sustainable agriculture. But support for taxing farm chemicals is, as one might suspect, related to chemical use, although only moderately. Thus, increasing taxes on

farm chemicals might be a suitable alternative policy option to the more traditional, expensive, and not necessarily effective options of educational programs, technical assistance, and cost sharing.

Currently there is wide interest in promoting sustainable agriculture. However, the study provides evidence that the research, information, and policy needs of sustainable farmers are not being addressed adequately. The existing institutional providers of research, information, and policy continue to be more attuned to the needs of conventional farmers, as revealed by the sustainable farmers in this survey through their ratings of use, helpfulness, and importance of these institutional sources. Insufficient attention to these needs can curtail the adoption of sustainable farm practices. Existing institutions such as the land grant colleges, experiment stations, and extension services and their federal partner, the U.S. Department of Agriculture, must further recognize the needs of this group of farmers and give higher priority to meeting those needs.

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Congress reviewing progress made on pesticide law

Congress is currently reviewing the progress made in implementing the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), spepcifically the 1988 amendments regarding the reregistration of older pesticides. Under FIFRA, the regulation of pesticides is achieved through their registration, which signifies that the product has been reviewed by EPA, and that, at the time of registration, EPA determined its intended use presented no "unreasonable adverse effects" on humans or the environment.

"Pest control into the next century must include some new approaches to the broader issue of meeting both the need for adequate production of food and fiber, as well as for the continued sustainability of our natural resources base which makes that production possible," said James Aidala of the IAA in testimony before the House of Representatives Committee on Agriculture.

"Among these approaches, I would include not only changes to reward and foster low-input agriculture, but also regulatory and financial incentives to reward beneficial technological innovations, chemical or otherwise, to more successfully compete with existing pest control practices which may have adverse impacts on health or the environment."

Among the recommendations Aidala had for Congress for amending FIFRA when it will be reauthorized were accelerating the removal of problem pesticides, increasing research on alternative methods of pest control, and coordination of USDA and EPA on research such as that sponsored by the LISA program.

"If the pest problem were addressed as part of a total system of agricultural production of that producer, then alternatives such as crop rotation or changes in cultural methods might serve to keep the grower as an economically viable producer," Aidala testified. "Finding such answers requires regional, if not local, research into the precise nature of the pest problem, which takes time, research funds, and anticipation of regulatory problems."

Hospital switches to organic food for patients

The American International Hospital in Zion, Illinois, believes that the last thing sick people need is contaminated food--so it serves nothing but top-quality, certified organic foods. The private 87-bed hospital switched to a total organic food program two years ago because its owners were strong believers in nutrition and fitness.

One of the hospital's biggest challenges in establishing its organic menu was finding recipes: it couldn't find any books about cooking large quantities of fresh organic foods.

American International may be the only hospital that serves an exclusive all-organic menu; few others have done so because of cost and irregular supply, hospital food directors say. "Many of our patients come here because we cater to their nutritional needs," says Director of Food Services Tim Curren. "Our nutrition program is working very well, and our patients look and feel better."

In the face of change: A rapid reconnaissance survey of Northwest horticultural crop producers

Laura S. Brophy, Helene Murray, Larry S. Lev, Richard P. Dick, Lorna M. Butler

Abstract. *A rapid reconnaissance survey (sondeo) of twenty-five western Oregon and Washington horticultural producers was conducted using interdisciplinary interviewing teams and flexible on-farm interviews. The group interviewed included both certified organic and conventional farmers who are adopting innovative production methods. Our objectives were to determine the primary factors affecting the choice of farming methods, to identify growers' responses to these factors, to examine the effectiveness of the sondeo technique for gathering such information, to build a team for the longer-term studies, and to locate growers to participate in the longer-term studies. The growers shared characteristics that crossed organic-conventional boundaries. Less experienced growers identified practical crop management issues as their primary problems, while the more experienced ones were concerned with labor and regulatory problems. Most conventional growers were reducing their reliance on agricultural chemicals; organic producers generally used fewer agricultural chemicals, but many relied on organically certified insecticides. A primary regulatory concern among conventional growers was the loss of pesticide registrations for minor crops. Both organic and conventional growers were concerned about government regulation of farm labor, particularly increased paperwork and changing immigration law. Many growers attempted to provide good working conditions to retain a reliable labor force, but a few are mechanizing the harvest to reduce labor requirements. They were aware of the increasing public interest in the health aspects of agricultural methods and were responding with modified chemical use, direct involvement in public education, and membership in commodity groups, cooperative marketing groups, and other grower organizations. The sondeo was a fast and low-cost method for gathering information and provided team members with an interdisciplinary perspective that will be valuable in future research.*

Key words: sondeo, survey, farming systems research, horticultural systems, innovative agriculture, sustainable agriculture, team research

Introduction

Rapidly changing social, economic, and environmental circumstances are contributing to a redefinition of the complex relations between society and the agricultural production sector. In the face of these changes, both agricultural producers and the land grant university system must develop new strategies to survive and flourish. This article reports the efforts of an interdisciplinary group of university researchers and extension personnel to learn new ways of working with agricultural producers using rapid rural appraisal (RRA) methods. RRA methods are a fast and low-cost way of gathering information about farmer knowledge and circumstances (Chambers, 1981; Beebe, 1985).

The project, which is part of the U.S. Department of Agriculture Low-Input Sustainable Agriculture (USDA/LISA) program, was designed to assist agricultural producers in providing not only inexpensive and plentiful food but also greater assurances of food safety, environmental stewardship, and socially responsible labor practices. A major goal of the national USDA/LISA program has been to increase farmer participation in technology development and transfer. The western Oregon and Washington project was initiated to address these issues with a farm-centered, multidisciplinary research and extension program.

As the first step in this research, two component projects were conducted: a telephone survey of production practices and a rapid reconnaissance survey (sondeo). The growers who served as sources of information for the sondeo will be full participants in future on-farm and research station experiments based on the case study and survey results.

Sondeo approach

The Farming Systems Research and Extension (FSR/E) approach was developed to improve the focus and efficiency of agricultural research and extension activities (Byerlee et al., 1982). Although first employed in developing countries, FSR/E methods have also gained favor in the United States. A sondeo, a type of RRA survey, is often one of the first

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steps in the FSR/E process (Chambers, 1981; Hildebrand, 1981; Beebe, 1985).

Translated from Spanish, "sondeo" refers to the act of sounding, exploring, and fathoming. The term was first applied to FSR/E work by the Guatemalan Institute of Agricultural Science and Technology (Hildebrand, 1981). In a sondeo, interdisciplinary teams of social and agricultural scientists conduct informal, unstructured interviews with farm families. A sondeo is intended to provide a rapid, preliminary sketch of the farming systems under study and does not seek to provide the type of statistical data common in more conventional research methods. Rather than quantifying crop growth parameters and input use levels, for instance, the sondeo is used to identify broad categories of strategies and responses and to classify respondents within these categories. Nonetheless, several researchers have reported that no major results from rigorous sondeo-type surveys were contradicted by follow-up formal surveys (Collinson, 1981; Crawford and Franzel, 1987).

The sondeo approach has demonstrated several advantages over more traditional survey or interview approaches:

1) it allows quick implementation and analysis;

2) it involves the farmer in a flexible interview process, permitting in-depth consideration of issues within a whole farm context;

3) it fosters interdisciplinary team interaction and thus provides the expertise to deal with the complex issues facing farmers;

4) it allows farmers an opportunity to help set research priorities, thereby improving the responsiveness of agricultural research institutions.

Among rapid rural appraisal methods, the sondeo process is particularly effective in forging effective working relations across the diverse disciplinary backgrounds of team members (Hildebrand, 1981). The sondeo also sets in motion longer-term research and extension efforts that continues to depend on direct farmer participation.

A sondeo was conducted in March and April, 1989, in western Oregon and Washington with the following objectives:

1) identify the factors influencing farm management among innovative growers;

2) examine how innovative growers with farms of different sizes and production methods are responding to these challenges;

3) examine the usefulness of the sondeo as a research and extension tool;

4) identify collaborating growers for longer-term project participation.

Methods

To help understand agricultural change in western Oregon and Washington and to help design a strategy for future research and extension activities, the sondeo focused on innovative organic and conventional growers. For the purposes of this paper, "organic" farms are defined as those certified by Oregon Tilth or the Washington State Department of Agriculture. "Conventional" farms are those not adhering to these guidelines, and "combined" farms are those with a mix of organic and conventional production.

The Sondeo Team consisted of researchers and extension personnel specializing in horticulture, agronomy, anthropology, plant pathology, plant ecology, weed science, entomology, soil science, and agricultural marketing and economics. Several team members have previous FSR/E and other interdisciplinary experience. The Sondeo Team planned the sondeo research, and its members participated in interviews as their schedules permitted. The sondeo provided the team with an initial opportunity to work together and develop a common understanding of research and extension priorities. In general terms, the sondeo required the social scientists to focus on the complex technical issues that confront producers and required the biological scientists to consider the equally complex social and economic issues.

Initial lists of growers to interview were submitted by county extension agents and other agriculturalists. From these initial lists, the Sondeo Team chose growers to be interviewed based on the following criteria:

1) crops grown include caneberries (*Rubus* spp., including raspberries a blackberries) or vegetables;

2) grower has been involved in pr duction agriculture for a minimum three years;

3) grower appears to be using or tempting to adopt innovative agricu tural practices, in the opinion of the in vidual suggesting the grower as participant;

4) grower is potentially willing to c operate in future project activities.

Farms for the sondeo were selected include a broad range of crop manag ment and marketing strategies. T group of twenty-five farms was not i tended to provide a statistically represe tative sample of western Oregon a Washington horticultural producers, b rather to focus on innovation.

The interview team, for most far visited, included the local county age a social scientist, and one or more biolo ical scientists. The team size was ke small to encourage informal discussio Each team member followed an outli of questions as a flexible guide to t interview process. This permitted a r laxed interview, revealing details th might not have been obtained in a mo structured format.

A sondeo provides an initial bro sketch of farm practices and proble and is generally a component of broad research efforts. This sondeo was pr ceded by a structured, statistically val telephone survey quantifying speci components of the sondeo. The te phone survey included 397 vegetable a small fruit producers in western Oreg and Washington, chosen at random fro extension and commodity group lis We extracted a subsample of 225 bro coli and small fruit growers from t telephone survey. This subsample w selected because its crops are similar those of the sondeo group. It will be us for comparison with the sondeo group this paper.

Results and discussion

Farm descriptions

Farms in the sondeo are located western Oregon and Washington, fro

the Willamette Valley to the Skagit Valley. Of the twenty-five farms visited, thirteen were conventional, nine were organic, and three were combined operations. Small fruit and vegetable growers were represented across organic and conventional farms of all sizes.

About half the farms were small, ranging from 3 to 35 ha, while the remaining farms ranged from 80 to 810 ha (Table 1). Three small farms (less than 10 ha) used conventional production methods, and two farms over 80 ha were entirely organic or used both organic and conventional methods. Growers with small farms (less than 40 ha) were generally less experienced, averaging eight and one-half years in production agriculture, while most of those farming 80 to 810 ha were lifelong farmers. However, there were exceptions: two growers farming 4 ha had 12 and 15 years experience.

The telephone survey, conducted in February and March, 1989, highlights differences between the sondeo group and the random sample of 225 broccoli and small fruit growers in the same geographic area (Table 1). The telephone survey categorized only 3 percent of the producers as organic, but 36 percent of the growers in the sondeo managed organic farms. The average area in production was larger for the telephone survey producers (151 ha) than for the sondeo producers (124 ha). This difference can be seen at both extremes of the farm size spectrum. Only 23 percent of the telephone survey farms were smaller than 20 ha versus 44 percent for the sondeo growers. At the other end of the scale, 43 percent of the telephone survey farmers had over 100 ha in production versus 36 percent for the sondeo producers. Small farms predominated in the sondeo group because many organic farms were deliberately included. Length of farming experience presents a similar relationship: the sondeo showed 44 percent with 10 years of experience or less, but the telephone survey had only 25 percent in this category. Thus, the sondeo growers were not average, nor were they intended to be. Rather, as discussed above, the sondeo group was selected to provide a snapshot of current farming strategies among agricultural innovators.

Problems and opportunities

Most of the primary farm-related problems described by the sondeo growers fit into three categories: crop management and production, labor availability, and government regulation. Of these three, government regulation was the most commonly cited problem (Table 1). The telephone survey did not address this issue in a comparable format, so no comparison could be made between the two surveys.

Table 1. Comparison of sondeo and telephone survey respondents.

	Sondeo (n = 25)	Survey[1] (n = 225)
Type of operation		
Organic producers (%)	36	3
Farm size and years of experience		
Land in production (mean, ha)	124	151
Less than 20 ha in production (%)	44	23
More than 100 ha in production (%)	36	43
10 or less years farming (%)	44	25
Major farm-related problems[2]		
Crop management and production (%)	32	—[3]
Labor availability (%)	28	—[3]
Government regulation (%)	44	—[3]

[1] Western Oregon and Washington USDA/LISA Project telephone survey of production practices conducted in February/March 1989.
[2] Percent of sondeo group who described major farm-related concerns within the listed categories. Since some growers described major concerns in more than one category, percentages sum to more than 100%.
[3] Telephone survey did not address this issue in a comparable format

The ranking of problems by the sondeo growers appeared to be more closely related to length of experience than to the method of production. Eight of the eleven growers with 10 or less years experience were most concerned with practical crop production problems. Weed control was the primary problem cited by three of these eleven growers. Other problems included soil fertility, timing of operations, plant diseases, and postharvest handling. Since eight of these eleven growers managed certified organic farms, the limited availability of organic crop management information may partly explain this relationship. However, all three less experienced conventional growers also cited weeds or lack of crop management advice as primary problems.

The fourteen growers who had more than a decade of experience generally regarded their primary problems as labor related or regulatory. For example, six cited labor shortages among their primary problems, and most related those shortages to changes in immigration policies. Six out of fourteen growers were troubled by the loss of pesticide registrations associated with the Environmental Protection Agency re-registration requirements; another three cited government regulation and the associated paperwork as a primary problem. Land supply and land tenure were primary obstacles to three of the fourteen more experienced growers. Other concerns included marketing, cash flow, and availability of capital.

Many of the larger farms produced crops on contracts with food processors. Processors generally provide crop management advice to contract growers. This may partly explain the observation that crop management was not usually described as a major concern by the more experienced growers. The processors set strict guidelines for pest control, often resulting in prophylactic applications of pesticides. Consequently, the demand for high-quality, cosmetically unblemished food affects how often growers use pesticides.

In contrast, the operators of many smaller farms, particularly those using organic production techniques, were members of wholesale cooperatives.

These cooperatives provide some crop management advice to their members and provide marketing services. They coordinate production among co-op members to maintain a consistent supply of produce to buyers, although several growers thought that supply and demand predictions were still not smoothly linked. Cooperatives such as these provide a way for operators of smaller farms to participate in the competitive wholesale produce market.

Although sondeo farms have been identified as organic, conventional, or combined, the results indicate that problems and solutions within the sondeo group cut across these boundaries. The sondeo confirmed other research indicating that rigid categorization of farms is not a foolproof means of predicting response to production problems and policy issues (Esseks et al., 1990).

Approaches to management problems

Crop management. Approaches to practical crop management problems varied by type of operation. Conventional growers used a broad range of pesticides and cultural practices to manage weed, insect, and disease problems, while organic growers relied primarily on nonchemical weed and disease controls. However, this distinction was much less sharp than the labels "organic" and "conventional" might suggest. At least five of nine completely organic operations made extensive use of insecticides approved by the organic certification agencies in Oregon and Washington, and many conventional growers were reducing agrichemical use, as described below.

The sondeo indicated that crop management techniques crossed organic-conventional boundaries. Regardless of whether weed control was viewed as a primary problem, twelve of the twenty-five growers used cover cropping, rotations, or mulching as weed management techniques. One grower was experimenting with a single-species winter annual weed cover crop. Field monitoring by representatives of agricultural chemical and processing companies or by independent crop consultants was mentioned as an important management tool by nine of the fifteen most experienced growers. Seven of these nine were conventional operations, one was combined, and one organic. Soil and plant tissue nutrient analysis were used regularly by three organic growers, one conventional, and

Pesticide registration losses. Although several growers cited the loss of pesticide registrations, particularly for herbicides, as a major obstacle, they did not specifically describe their solution to that problem, perhaps because future registration losses are unknown. However, solutions are likely to include alternatives to chemical pest control. The sondeo indicated that some farmers are already experimenting with alternatives. Twelve of sixteen conventional or combined growers interviewed during the sondeo currently are modifying their management techniques to reduce reliance on chemical pest controls. Predominant alternatives to pesticides among this group included cover cropping (used by six of the twelve) and pest monitoring (used by eight of the twelve).

The telephone survey provides a contrasting picture of changes in agricultural chemical use between 1984 and 1989 (Table 2). For the four categories of chemicals not used by organic growers, most growers reported no change in use level over the past five years. For chemical fertilizers, insecticides, and fungicides, more respondents reported increased than decreased use. Roughly equal numbers reported increased and decreased use of herbicides. Use of fertilizers and pesticides allowed by organic certification agencies increased, but these inputs were used by only a sma percentage of producers. Alternatives t pesticide use were less frequent amon the telephone survey respondents tha among the sondeo group. For exampl use of mulch was reported by less than 1 percent of the phone survey respondent and insect traps (one form of pest mon toring and an important component c integrated pest management) by only 2 percent.

Some of the sondeo growers dealt wit the problem of pesticide registration los by becoming involved in public policy either through direct lobbying o through grower organizations. Two o the thirteen conventional growers acte as lobbyists, while seven of the sixtee conventional or combined growers wer involved with commodity commission or other grower organizations that lobb on various issues, including pesticid regulations.

Labor management. Six of th twenty-five sondeo growers indicated th importance of labor to their operation and described their efforts to retain a steady, motivated, long-term labor force These six operations spanned the pro duction spectrum from 3 to 810 ha, in cluding organic and conventional farms Methods for retaining a consistent labo force included selection of crops tha provide employment throughout the sea son, bilingual management, provision o housing, personal support, retiremen benefits for managers, and other finan cial incentives.

In the sondeo group, three of the thir teen conventional growers and one of th

Table 2. Reported changes in agricultural chemical use in the last five years (percentage), random telephon survey[1].

Input	No Change	Increased	Decreased	Never used	Don't kno
Not allowed in Organic Production					
Fertilizer	60	20	13	4	3
Herbicides	53	20	19	5	3
Insecticides/ miticides	46	24	20	7	3
Fungicides	53	25	8	10	4
Allowed in Organic Production					
Fertilizers	31	13	4	47	5
Pesticides	32	15	4	41	8

[1] Western Oregon and Washington USDA/LISA Project telephone survey conducted in February/Marc 1989, n = 225.

organic growers stated that they are converting or planning to convert to mechanical harvesting to avoid future labor problems. Two organic farms and one conventional farm hire only local labor, circumventing potential problems with immigration law; these three were relatively small (under 24 ha).

Views of agricultural change

Growers in the sondeo group addressed three general themes in their views of agricultural change today: government regulation, public involvement in agriculture, and consumer education.

Government regulation. Increasing government regulation was seen as a problem primarily by operators of larger farms, for whom labor laws require a considerable amount of paperwork, and by those concerned with pesticide registration losses. Their responses to these concerns have been described. In contrast, increasing government involvement in defining and certifying organic food production was viewed as a benefit by organic growers. One grower stated that he believes certification helps legitimize organic growers and brings them into the mainstream of agricultural trade. In response to the need for certification guidelines, four of nine organic growers were involved with the certification agencies or their citizen advisory boards.

Public involvement in agriculture. A second theme in growers' views of agricultural change is the increasing public interest in food safety and environmental protection. In response, five conventional or combined growers are changing the chemicals they use or reducing chemical use. One conventional grower has eliminated aerial spraying to reduce conflicts with non-agricultural landowners nearby. Some growers are planning or contemplating conversion of some land they farm to organic production. Reasons for converting varied among respondents and included concern for their own health and that of laborers, a perceived increase in demand for organic produce, and economic incentives.

Consumer education. Growers agree that public education about how crops are grown is necessary, specifically noting that production of high-quality food requires a high level of management. In many cases intensive management consists of pesticide use. For some crops, higher labor costs are incurred when pesticide use is reduced. Growers in the study concurred that consumers need to understand the risks associated with agricultural chemical use and the environmental or economic tradeoffs of maintaining high-quality food. However, conventional growers stressed the role of education in convincing consumers that agricultural chemicals are used responsibly and that the risk of pesticides in food is lower than is portrayed by the news media. Organic growers believed that consumers need to be informed about the management constraints and costs of growing certified organic produce.

Some growers use their farms for on-site public education. One is a member of his local school board and organizes visits by school children to his farm. Another farm family hopes to encourage recreational visits to their farm by urban families. This family also is developing a new marketing niche with an on-farm store that will sell both produce and non-produce items such as locally made crafts.

The sondeo as a research and extension tool

The sondeo achieved its objectives of gathering information on innovative growers, the social and market forces affecting them, and their responses to those forces. The sondeo approach was also well suited to preliminary identification of management and production innovations adopted by a small number of growers. Historically, innovative, risk-taking growers have been largely responsible for implementing new agricultural production technology. The sondeo approach allowed the team to focus on the unique whole farm characteristics of each operation, as compared to the telephone survey which divided the farms into components and obtained detailed information about those parts. The telephone survey clarified the relationship of the sondeo group to the broader spectrum of growers in this region.

One of the most important benefits of the sondeo approach was that it promoted interaction among social and biological researchers, extension personnel, and growers. Our experience confirmed that individual team members record and interpret interview data differently. For example, one grower in the study has limited crop rotation options because he grows perennial berry crops. Therefore, he plants the same annual crop on the same piece of land for four to five years. After the visit, team members discussed this practice from a variety of viewpoints. One team member was concerned about future problems from a persistent soil-borne disease prevalent in the area. Another pointed out the grower's awareness of this potential disease problem and noted that the grower had modified his cultural practices to reduce the likelihood of its occurrence. A third member expressed concern about the potential for weed shifts with the modified cultural practices, while still another described the grower as innovative for developing a system that attempted to circumvent a potential problem. The team's diversity of viewpoints and subsequent discussions were important in developing an accurate, integrated assessment of the farm situation. Through this kind of interaction, researchers and extension personnel were encouraged to incorporate their disciplinary expertise into a larger farming systems context, including both socioeconomic and biological elements. This meant that the sondeo not only generated valuable ideas, but also gave team members a wider perspective on their own research and extension work.

Summary

The sondeo approach provided a good method for assembling information from growers and exchanging expertise among researchers and extension personnel. The informal but focused approach provided a good learning and team-building environment for the sondeo team.

The major off-farm influences on western Oregon and Washington horticultural producers in the sondeo group relate to labor availability and to public concern over the use of pesticides. Some

growers in this study are developing alternative approaches to reduce chemical use. However, guidelines set by the food processing industry limit the options of many large-scale growers. Despite this limitation, many producers, both large and small scale, are responding to market demand for more organic produce.

The sondeo and telephone survey indicated that innovative growers, whether organic or conventional, have much in common when compared to the broader farming public. By implication, these innovators have much to offer researchers and other growers.

Despite the diversity of farms surveyed in the sondeo, parallels were more striking than contrasts. Growers in the sondeo are responding to environmental and social pressures and practical crop management problems with innovative management, blurring the perceived boundaries between organic and conventional farming. The characteristics shared by the growers we interviewed provide encouraging evidence of adaptability to today's changing agriculture. Rather than forming two opposing camps, innovative organic and conventional farmers may be able to share information in a mutual effort towards a better future for agriculture.

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Farm profiles invited

For its new department on alternative agriculture profiles, the AJAA welcomes short articles describing farmers who have adopted interesting alternative practices. The articles should include five elements: a brief description of the farm; the problems that made the farmer look for an alternative approach and the reasons why the alternative seemed plausible; a summary of the basic principles behind the alternative (possibly in a sidebar if it interrupts the flow of text); a discussion of how well the alternative has worked; and a discussion of the applicability of the alternative for other farms. The length should be 1500 to 2000 words.

Submissions must be accompanied by a release, signed by the farmer, giving permission for this material to be published in the *American Journal of Alternative Agriculture*. Vol. 3, No. 4, of the AJAA has a further description of the department (page 188); or query the editor for further information. Send submissions to the Editor, AJAA, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770.

Farm conservation programs not strictly enforced, study says

Little monitoring and enforcement of federal farm conservation programs has been done by USDA agencies to date, according to a new study by the Soil and Water Conservation Society. Authors of the report, "Implementing the Conservation Title of the Food Security Act," witnessed a number of apparent sodbuster and swampbuster violations, but the farmers involved had not lost program benefits as a result.

In a sampling of seven counties in the Corn Belt, Great Plains, and Pacific Northwest, the researchers found that a quarter of all conservation practices scheduled to be applied by farmers in 1990 or prior years either were not in place on the farms observed or did not meet federal requirements. The compliance provisions of the 1985 Food Security Act make receipt of federal farm program benefits--including commodity price supports, agricultural credit, and crop insurance--contingent on the application of soil erosion control measures and wetlands protection.

Problems cited with implementation of the swampbuster policy had to do with USDA's lax enforcement of the policy and with differences of opinion between farmers and government officials over the definition of a wetland and the policy's intent.

"The main problem with USDA's implementation of sodbuster is that little or no attention is being given to enforcement of the policy at some locations," said Max Schnepf, who directed the study for the Society. "USDA is not requiring its local officials to certify the application of conservation measures on a sodbusted field or to check to see if a farmer is following his or her conservation plan." For more information, contact SWCS, (515) 289-2331.

The growing importance of food safety to Japanese consumers and its implications for United States farmers

Raymond A. Jussaume, Jr.

Abstract. *Consumer cooperatives in Japan, which is by far the United States' largest overseas market for agricultural commodities, expanded rapidly in the 1980s. Their recent success, according to Japanese reports, has been due to their responsiveness to increasing consumer demand for foods produced with minimal use of petrochemical inputs. I present data that confirm this claim by showing that the high level of concern that Japanese consumer cooperative members have about food safety is the main reason they give for joining cooperatives. I then discuss the significance of this trend for American agriculture, in particular whether Japanese consumer cooperatives could become a marketing channel for Americans who specialize in producing food with less intensive use of agricultural chemicals.*

Key words: Japan, consumer cooperatives, food safety, trade, agriculture

Introduction

A fundamental issue in both academic and popular discussions of alternative agricultural production systems is their economic viability. Although the macroeconomic impacts of alternative agriculture have been little studied, the few analyses that have been completed have suggested that its widespread adoption in the United States would lead to a decline in agricultural exports (Crosson and Ekey, 1988). However, it is difficult to ascertain its effect because of the problems inherent in predicting market demand for commodities produced under lower-input agricultural systems, which can be more expensive but perceived by consumers to be safer than commodities produced under conventional systems. American agriculture is integrated into the world economy, which is why the oversaturation of world agricultural markets in the 1980s led to a significant decline in United States agricultural exports and a corresponding fall in prices for American agricultural commodities (National Commission on Agricultural Trade and Export Policy, 1985; O'Rourke, 1989). One way American agriculture could improve its competitive position in world agricultural markets would be to meet the overseas demand for foods produced under lower-input agricultural management systems, if this demand is strong.

This paper deals with one aspect of this question by looking at the reasons for the recent rapid growth of consumer cooperatives in Japan. Japan is a logical starting point for examining whether those who utilize lower-input agricultural production systems can compete in world agricultural commodity markets because it has been the United States' principal customer for agricultural exports for more than a quarter of a century (McDonald, 1985). Indeed, the value of all American agricultural products sold to Japan in recent years has exceeded total sales, to the U.S.'s next three largest customers, i.e., the U.S.S.R., the Netherlands, and Canada (JETRO, 1986).

A study of Japanese consumer cooperatives and the reasons that an increasing number of Japanese consumers are joining them is significant for Americans involved with alternative agriculture because Japanese consumer cooperatives, in 1973, made the provision of "safe food products" their principal marketing strategy. (The Japanese expression *Shokuhin Anzensei*, which literally translates as "food products safety," is commonly used in Japanese consumer cooperatives' advertisements and promotional literature.) The recent success of the Japanese consumer cooperative movement is a direct result of this strategy. Later, I will present data to show that Japanese consumers join cooperatives primarily because they want foods produced with fewer agricultural chemicals. I then will argue that United States producers have an opportunity to meet the Japanese demand for safe foods through consumer cooperatives as well as other distribution channels.

Background on Japanese consumer cooperatives

The Japanese consumer cooperative movement, like its counterparts in the United States (Sommer, 1984) and Can-

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ada (Labrecque, 1986) has a long history. According to Kawano (1986), the first consumer cooperative, the *Tokyo Kyoritsu Shosha*, was established in 1879. As in Europe and North America, the early Japanese consumer cooperative movement was heavily influenced by the Rochdale consumer cooperative, which was established in Manchester, England, in 1844. These first Japanese consumer cooperatives were organized by industrial workers and government employees. Their primary purpose was to provide commodities at low prices. Because of the economic difficulties of running a cooperative and a hostile political environment, these early cooperatives rarely survived more than a few years. The earliest Japanese cooperative still in existence, the *Nada Seikyo*, was founded in Kobe in 1921. It merged with the *Kobe Seikyo* in 1960 to become what is now the largest consumer cooperative in all of Japan.

The Japanese consumer cooperative movement blossomed in the late 1960s and early 1970s, when most of the large consumer cooperatives active today were established (Nomura, 1986). Many factors, including the first "oil shock" and the growth of large retail chains in Japan, contributed to the increase in the number and size of cooperatives. However, the primary reason is generally considered to have been increasing public awareness of environmental degradation and its effects on food production. The key event occurred in 1973 when the National Association of Consumer Cooperatives decided that providing safe food products, not the traditional priority of low cost, would be its primary marketing strategy (Katsube, 1977). This change was not felt immediately but it eventually led to substantial growth for Japanese consumer cooperatives.

Akiya (1988) reports that consumer cooperatives in Japan were stuck at a 1 percent market share (food and non-food retail sales) throughout much of the 1970s. This began to change in the late 1970s. The cooperatives went from a 1.09 percent nationwide retail market share in 1978 to a 2.41 percent share in 1986. Given the great size of the Japanese retail sector and the fact that consumer cooperatives are primarily involved in food sales, this is a very large percentage. Table 1 shows the sharp increase in both the number of cooperative members and the yen value of total sales in the first half of the 1980s. By 1986, there were 531 independent consumer cooperatives active in Japan, with a total membership of just over 9 million, and with 1.85 trillion yen in retail sales (Akiya, 1988). At an exchange rate of 175 yen per dollar, the prevailing exchange rate that year, this comes to $10.6 billion. This was greater than the sales level of any single Japanese supermarket or department store chain.

Table 1. Recent Growth in Japanese Consumer Cooperatives.

Year	Membership		Total Sales		Yearly Sales Per Member	
	Number of Members*	Yearly Increase	Value (Million Yen)	Yearly Increase	Value (Yen)	Yearly Increas
1979	5,883,000	3.9%	875,301	12.3%	148,780	8.1%
1980	6,124,000	4.1	1,041,145	18.9	170,000	14.3
1981	6,584,000	7.5	1,168,273	12.2	177,440	4.4
1982	7,125,000	8.2	1,265,324	08.3	177,590	0.1
1983	7,760,000	8.9	1,409,940	11.4	181,690	2.3
1984	8,393,000	8.2	1,579,203	12.0	188,160	3.6
1985	9,400,000	12.0	1,762,584	11.6	187,510	-0.3

* Except for university cooperatives, membership in Japanese consumer cooperatives is generally b household.

Adapted from Akiya (1988, p. 50).

Why have Japanese consumer cooperatives done so well in the 1980s? One factor is certainly the emphasis that they have placed on professionalizing their management techniques (Nomura, 1986). Like traditional American cooperatives (Sommer, 1984), cooperative members in Japan are not required to do any unpaid work for the cooperative. Instead, members pay a fixed entrance fee and frequently get small rebates based on the amount they purchase. As a result, the operating efficiency of the cooperatives has been improved because employees are paid professionals. The success of this strategy is shown by the fact that, of the forty largest non-store Japanese retail firms, seven are consumer cooperatives (Nihon Ryutsu Shinbun, 1989).

Another explanation for their success is their use of home deliveries. In many smaller cooperatives, more than half of all sales are made this way. The cooperative organizes neighborhood members into a traditional group of between four and seven households, known as a *Han* and delivers to them as a unit to the home of one member once a week. The group is responsible for dividing up the order and for turning in future orders and payment. By building on neighborhood social relationships, the consumer cooperative movement in Japan has developed an effective marketing strategy that not only is sensitive to neighborhood social relationships, but in some cases actually strengthens them.

However, I argue that the main reason most Japanese households join cooperatives is the cooperatives' attention to food safety. In recent years, Japanese consumers, like their counterparts in the United States (Sachs et al., 1987; Sloan 1985; Steel, 1989) and Europe (Conning 1988; O'Beirne, 1988), have become increasingly worried about food safety. As in the U.S., the consumer movement in Japan began to gain momentum in the late 1960s and early 1970s, with the cyclamate issue being one of the key politicizing issues (Kirkpatrick, 1975). A recent survey of consumers in the United States and Japan has shown that the level of concern over food safety in Japan may be even greater than in the United States (Jussaume, 1989). Data will now be presented to support the claim that this concern is the primary reason that Japanese consumers join cooperatives.

Data

I collected the data presented in this paper during a research project on food consumption attitudes and behavior in the summer of 1988 in the Kansai region

of Western Japan. As part of that study, a self-administered questionnaire was distributed to households belonging to consumer cooperatives in Kobe and Kyoto. In Kobe, questionnaires were distributed by the *Nada Kobe Seikyo* cooperative to a random sample of 800 of its member households. Of these, 328 were returned, a response rate of 41 percent. In Kyoto, surveys were distributed by the *Kyoto Seikyo* cooperative to a sample of 600 households, stratified by neighborhood. Of these, 298 were returned, a response rate of nearly 50 percent. A comparison of consumer cooperative membership attitudes in these two cities is very useful because, although they are located only 25 miles apart, these two cities are considered by most Japanese to have very different characters. Kobe, the first Japanese seaport opened to trade with the West in the 19th century, has a reputation of being a stylish, trendy city receptive to outside cultural influences. Kyoto, on the other hand, was the home of Japanese emperors from the 8th to the 19th century and is known for its traditional manners and thinking.

The questionnaire was designed to collect information on cooperative members' food consumption attitudes and behavior. It was prepared after reviewing previous examples of Japanese and American surveys on food consumption, to be sure that it was culturally sensitive to the behavior and perceptions of Japanese consumers. One set of items was prepared specifically to learn why cooperative members had joined their local consumer cooperative.

Why Japanese join consumer cooperatives

Over half the surveyed Kobe cooperative members and more than two-thirds of the Kyoto cooperative members reported that their primary reason for joining their cooperative was to be able to buy safe food products (Table 2). The least common of four possible answers was to buy cheaper foods. Only 2 percent of the Kobe members and none of the Kyoto members gave this as the principal reason for joining their cooperative. The significantly lower proportion of Kobe members who joined their cooperative to buy safe food is partly attributable to that cooperative's large size. Over half of all households in the city of Kobe now belong to the *Nada Kobe Seikyo*. In 1985, that cooperative had nearly 700,000 member households and 97 stores (Akiya, 1988). It also has its own food processing factory, physical fitness center, and food safety testing laboratories. The *Nada Kobe Seikyo* has become so large that in many neighborhoods it now is more convenient to shop there than at a supermarket or department store. This would explain why nearly one-third of the Kobe respondents mentioned convenience as their primary reason for joining the *Nada Kobe Seikyo*.

Still, the main reason most of those responding to both surveys gave for joining a consumer cooperative was a desire to purchase safe food. This apprehension over food safety and its linkage to cooperative membership may surprise Americans, but it is hardly a surprise to Japanese observers. Responding to the increasing consumer desire in Japan for safe foods, as opposed to inexpensive foods, is frequently given as the secret to Japanese consumer cooperatives' recent success in expanding the scale of their operations throughout the country (Katsube, 1977; Nomura, 1986). Consumer cooperatives are well known in Japan as a principal promoter of what is referred to as the *Teinouyaku* (Reduced Agricultural Chemicals) production system.

Japanese consumer cooperatives have achieved their success through a classic capitalist marketing strategy. Cooperative managers have understood that the most important step in an effective marketing strategy is to find out what products potential customers want (Stern and Sturdivant, 1987). Consumer cooperative directors began to recognize in the 1970s that many Japanese consumers had become concerned about the use of petrochemical compounds in Japanese agriculture and because of their increasing incomes were able to pay more for what they perceived to be safe food. These attitudes are reflected in the answers to two additional questions in the survey (Tables 3 and 4). Over 60 percent of the membership in both the Kobe and

Table 2. Why Japanese Consumers Join Cooperatives.

	Nada Kobe Seikyo	*Kyoto Seikyo*
To buy safe foods	53%	70%
To buy cheaper foods	2	0
Because it is convenient	33	10
Because my friends belong	9	18
Other reasons	4	2

Table 3. Should Farmers Use Less Pesticides?

	Nada Kobe Seikyo	*Kyoto Seikyo*
Strongly agree	60%	64%
Agree	34	27
Neither	5	9
Disagree	2	<1
Strongly disagree	0	0

Table 4. How Much Cooperative Members Are Willing To Pay For Food Certified Free Of Agricultural Chemicals.

	Nada Kobe Seikyo	*Kyoto Seikyo*
Double	9%	6%
Fifty percent more	15	15
Some more	72	72
No more	3	3
No answer	1	5

Kyoto cooperatives stated that they "strongly agree" with the statement that "Farmers should grow food with less pesticides" and an additional 34 percent in Kobe and 27 percent in Kyoto agreed with that statement. In addition, more than 90 percent of the respondents in both cities said that they "were willing to pay higher prices for foods that were certified free of agricultural chemicals and food preservatives." Although most respondents expressed a willingness only to pay some more, nearly one-quarter in Kobe and one-fifth in Kyoto said that they were willing to pay 50 percent more or even double for food certified free of agricultural chemicals. The fact that these individuals have joined consumer cooperatives, which frequently charge more than Japanese supermarkets for the same products, shows the consistency between the attitudes and behavior of these consumers.

It is difficult to prove that the Japanese consumer cooperatives' safe food policy caused their recent expansion. However, the evidence presented above indicates a strong connection between their operating principles and their members' attitudes. This match is further shown by the educational programs that cooperatives run. For example, the cooperatives educate members on the costs and benefits of various agricultural practices, including those related to cosmetic appearances. Cooperative employees will explain to members that certain blemishes on fresh produce are not related to quality and that, if members are willing to accept them, farmers can grow the crop with fewer chemical applications.

Japanese consumer cooperatives and imports

The desire of many consumers to purchase safe foods is unquestionably real and is a marketing opportunity for food producers who use fewer chemical inputs. However, the question remains whether this opportunity can be exploited by Americans. Are Japanese cooperative members willing to purchase imported food products? Could American alternative agricultural producers market their commodities as safe foods through these cooperatives?

First we must discuss what the cooperatives consider to be "safe" foods. Unfortunately, these standards cannot be stated precisely, not only because they vary by commodity, but also because each cooperative is free to set its own standards. Although some cooperatives have been known occasionally to market foods considered organic, the cooperatives do not bind themselves to an organic standard. Rather, they support the system called *Teinouyaku*, literally "reduced agricultural chemicals."

The following is an example of how the *Teinouyaku* system works. "X" producer cooperative is a specialty farmers' cooperative that I investigated during the research in Kobe and Kyoto. It is in a prefecture adjoining the Kansai metropolitan area and supplies fruits and vegetables to the cities there, primarily under contract to consumer cooperatives. Although most local producer cooperatives have existed in their current form since the end of World War II, "X" cooperative was established in 1980 in direct response to the marketing opportunities presented by consumer cooperatives and other businesses looking for commodities produced with less agricultural chemicals. Between 1980 and 1988, "X" cooperative grew to 800 farm household members, all of whom use a *Teinouyaku* system, as well as 30 full-time and 40 part-time employees.

As part of their *Teinouyaku* strategy, farm households in "X" cooperative use approximately half as much agricultural chemicals as other Japanese farmers. The specific chemicals that can be applied to each particular commodity, and the timing of each application, are established through negotiations with each consumer cooperative it sells to. There is no nationwide standard for *Teinouyaku*. Each consumer cooperative decides its own standards with its suppliers. The same applies to contract enforcement and pricing. In the case of "X" cooperative, contracting consumer cooperatives are allowed to make surprise inspections of individual member's farms to verify adherence to standards. Prices are determined in advance, with representatives from the consumer cooperatives and "X" producers' cooperative reviewing production costs, deciding on a fa profit, and then agreeing on a sellin price for each commodity some two t three months before the harvest. If ma ket prices change substantially, renegot ation is possible.

The flexibility of this system enable each consumer cooperative to buy proc ucts that it considers to be safe, fro whatever sources it believes to be rel able, including overseas suppliers. Sinc each cooperative has its own standard and information systems, it is difficu to obtain accurate information on th amount of imports flowing through a Japanese cooperatives. However, th general openness of the cooperatives shown by information obtained from th *Kyoto Seikyo*, one of the two cooper tives surveyed for the current study, reported in Sakamoto (1990).

During the week of April 16th, 199 the *Kyoto Seikyo* offered 256 food an non-food items for sale. Of these, 9 wer sold as imported, meaning they wer produced, packaged, and/or processe overseas. They included garlic buds fro the People's Republic of China, a variet of fish from around the world, and lem ons and grapefruits from suppliers in th United States who guaranteed, amon other things, that their shipments wer not treated with the fumigants thiobenz dol (TBZ) and ortho-phenylphen (OPP). Another 63 items sold throug the *Kyoto Seikyo* that week were mad primarily from imported materials. Thi category included a wide range of pro cessed foods, including noodles and bak ery goods, made primarily from im ported wheat and soybeans. It is unclea what standards were used in determinin the safety of these commodities, but co operative standards usually are stricte than the government's. At the *Nad Kobe Seikyo* testing laboratories, I sa imported cherries and wheat from th United States being tested for residue The technicians said that their residu tolerance standards were stricter tha the government's by at least a factor 10 and that some shipments of America wheat had recently been rejected becaus they failed to meet the cooperative standards.

Data on sales by the *Kyoto Seikyo* als show the high volume of imports ha

dled by consumer cooperatives. Sakamoto (1990) reported that, during the week of February 12, 1990, sales of food products in the two import categories described above amounted to 1.15 billion yen ($7,187,500). This accounted for 14.4 percent of all retail sales made that week by the *Kyoto Seikyo*, and does not include the additional 24.7 percent of retail sales in the form of meat and dairy products produced in Japan primarily with imported feed grains. This shows that Japanese consumer cooperatives not only are a competitive force in the Japanese food retail sector, but that they are a distribution network for imported food products.

Discussion

Although it is difficult to obtain exact figures on the total market for imported "safe food products" in Japan, the above evidence shows that the market is large and growing, that Japanese consumer cooperatives have been successful in supplying that market, and that imports play a role in meeting that demand. Without better data, it is impossible to determine what particular commodities will be in demand, what safety standards will be required, and what prices cooperative buyers will be willing to pay. However, alternative agricultural producers in the United States potentially can sell to Japan, not only through cooperatives but perhaps also through other distribution systems.

The expanding consumer demand for safe foods in the United States is not unique and probably is not fleeting. Consumer demands for food safety are being expressed in different countries. One recent example of this phenomenon in Japan has been the decision on the part of the Japanese Consumers' Cooperative Union, as well as *Seiyu* supermarkets and *Mitsukoshi* department stores, to stop sales of lemons imported from the United States because traces of the herbicide 2, 4-D and the fungicide Imazalil were found on 13 lemons purchased from various outlets in the Tokyo metropolitan area. Although the residue levels were well below World Health Organization standards, the consumer cooperatives and selected other retailers thought it prudent to stop selling lemons imported from the United States (Japan Agroinfo Newsletter, 1990a, 1990b).

This case, and the survey data presented in this paper, are evidence of Japanese consumer sensitivity about food safety. These concerns have grown during the past decade and are not likely to disappear. This change, and the example of "X" producer cooperative, can be interpreted to mean that safe foods produced using a lower-input system in the United States can compete in the Japanese market and perhaps other overseas markets as well. This does not mean that adopting less chemically intensive agricultural practices will make global marketing easy. However, markets for safer food products appear to be growing, and businesses that are willing to serve this market can benefit economically and in the long run may gain a competitive advantage over those that are not willing to adapt.

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Integrating social, environmental, and economic issues in sustainable agriculture

Patricia Allen, Debra Van Dusen, Jackelyn Lundy, and Stephen Gliessman

Abstract. *In the past several years, researchers, educators, policymakers, and activists have initiated sustainable agriculture programs and efforts the world over. This development has sometimes been accompanied by a sense that it is time to stop discussing sustainability at a conceptual level and get on with the work of making agriculture sustainable. Our perspective is that it is critical to pursue a comprehensive definition of sustainability in order to set sustainable agriculture priorities and ensure that sustainable agriculture takes a path that does not reproduce problems of conventional agriculture. In this paper we briefly review some popular definitions of sustainable agriculture and find that their focus is primarily on farm-level resource conservation and profitability as the main components of sustainability. Others have challenged this approach for either not examining the social aspects of sustainability or for containing an implicit assumption that working on the environmental, production, and microeconomic aspects of sustainability will automatically take care of its social aspects. We propose an expanded conceptualization of sustainability--one that focuses on the entire food and agriculture system at a global level and includes not only environmental soundness and economic viability, but social equity as well. In this perspective, issues such as poverty and hunger are as central to achieving agricultural sustainability as those of soil erosion and adequate farm returns.*

Key words: agricultural sustainability, sustainability definitions, food and agriculture system, social equity, sustainability goals

Introduction

The long-term sustainability of agricultural systems concerns diverse groups of people. They emphasize different aspects of sustainability, from land stewardship and family farms to low external-input methods and food safety. These perspectives can be differentiated in two ways: sustainability defined primarily in terms of resource conservation and profitability; and sustainability defined in terms of pressing social problems in the food and agriculture system. Each of these perspectives has been illustrated in this journal by Lockeretz (1988) and Altieri (1988). In his review article on sustainability, Lockeretz documented primarily production-oriented components of sustainability. Altieri, on the other hand, pointed out that concentration on only the technological aspects of sustainability results in, among oth things, failure to distill the root caus of nonsustainability in agricultu While sustainability efforts need to a dress both social and technical issu they frequently overemphasize the tec nical, a problem we see originating in t way sustainability is often defined. O purpose in this paper is to discuss co cerns about current sustainability defi tions and suggest a definition based up a broader perspective.

Why continue to discuss definition?

Among those working in sustainab ity, there is often a feeling that we ne to devote less time to talking about t meaning of sustainable agriculture a more time to implementing it. While th is an understandable position, especial for those directly involved in producti agriculture, it also expresses a contradi tion. How can we form an improved a ricultural system if it has not yet be clearly conceptualized? Lockere (1988) queries, "Isn't something bac wards here?" and shows that, althou there is a surge of interest in agricultu sustainability, "even its most basic ide remain to be worked out." There is generally accepted set of goals for su tainable agriculture and little agreeme even on what and who it is we intend sustain (Allen and Van Dusen, 1990). it possible, for example, to both susta production efficiency and preserve t natural environment? Should we work

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sustain American farmers, affluent consumers, or rural poor--or should all of them be our priorities? Can we truly sustain one group without considering others? Without clarifying these goals, the necessary changes in cultural, infrastructural, technological, and political arenas are difficult to negotiate. If we want sustainable agriculture to pursue a path differentiable from that of conventional agriculture, we need to explicitly state and gain some consensus on these goals. A clear, comprehensive definition of sustainability forms the necessary theoretical foundation for articulating them.

Conventional agricultural priorities

Pursuing the dialogue on sustainability is essential in order to make visible the often invisible assumptions and priorities that have governed agricultural research and policy decisions leading to nonsustainable systems. Many of these assumptions and priorities also influence sustainable agriculture programs. Such an examination is critical if we are to avoid reproducing the problems engendered by conventional decision-making processes in the research, education, policy, and business institutions that determine the character of agriculture.

Dahlberg (1987) notes that assumptions and biases that may occlude the development of sustainable agriculture concepts include: separating ourselves from nature and viewing it as something that must be dominated; measuring progress by the increase in the applications of science and technology; emphasizing technology and formal social institutions over natural systems and less formal aspects of society; and failing to see how human societies fit into and are dependent on larger natural systems. We would add to Dahlberg's list the tendency to overlook the needs of human beings who are separated from us, whether it be by distance, by socioeconomic status, or by time (future generations).

Assumptions such as these have been institutionalized in educational and research programs. MacRae et al. (1989) note that many characteristics of the research process responsible for conventional agriculture's great productivity create obstacles to developing sustainable agriculture. Among these are overreliance on reductionism and quantification, scientists' belief in objective "truth," and the separation of research from its potential social consequences (that is, the belief that the potential consequences of research should not determine whether the research is undertaken). Along with Allen (1989), those authors also cite obstacles posed by a peer review system and publishing process that tend to reward individual "isolated" achievement while discouraging long-range interdisciplinary work and innovative ideas. This is aggravated by research funding from agribusiness sources, which encourages research on technology development rather than social analysis.

The same assumptions and biases that govern research and education are also embedded in much of U.S. agricultural policy. They are expressed primarily as short-term economic considerations such as maximizing production, minimizing production costs and consumer prices, and maximizing the market share of certain agricultural commodities. These priorities have largely been those of the agricultural sector and not necessarily those that are best for society at large (Dahlberg, 1986).

Predominant definitions of sustainability

Concepts of agricultural sustainability reflect many people's dissatisfaction with conventional agricultural priorities, especially the extent to which short-term economic goals have been emphasized over environmental and social goals. In response, a number of agricultural sustainability concepts have been developed under the terms "alternative," "regenerative," "organic," "low-input," and "sustainable." We are interested here in those definitions most commonly espoused in the agricultural research community, definitions that are predominant in the literature and are used as the basis of sustainability programs. It is useful to examine what priorities these definitions embody, how these priorities compare to those expressed in conventional agriculture, and how the development of sustainability would benefit by broadening these priorities.

Although sustainability definitions include a range of environmental, economic, and social characteristics, most focus somewhat narrowly on environment, resource conservation, productivity, and farm- and firm-level profitability. Francis (1988) defines sustainable agriculture as a "management strategy" whose goal is to reduce input costs, minimize environmental damage, and provide production and profit over time. The National Research Council (1989) defines alternative agriculture as food or fiber production that employs ecological production strategies to reduce inputs and environmental damage while promoting profitable, efficient, long-term production. For Harwood (1990) the three principles for sustainable agriculture are: "the interrelatedness of all parts of a farming system, including the farmer and his [sic] family; the importance of the many biological balances in the system; the need to maximize use of material and practices that disrupt those relationships." According to Ruttan (1988), enhanced productivity must be a key factor in any sustainability definition. MacRae et al. (1989) adopt a sustainability definition that emphasizes environmentally sound production practices. They note that sustainable agriculture today is characterized mainly by products and practices that minimize environmental degradation, although they also point out the potential to move beyond this restrictive application. In his review of sustainable agriculture definitions, Lockeretz (1988) stresses agronomic considerations, although he does note the connection between changing production practices and associated socioeconomic transformations.

Sustainability definitions such as these focus on environmental conservation, which is to be achieved through changing farm production practices without reducing farmers' profits. They challenge some but not all the assumptions that underlie agriculture's nonsustainable aspects, generally neglecting questions of social justice or devoting little specific language to it. Altieri (1988), for

one, has challenged the narrowness of these approaches and their implicit assumption that taking care of the environmental, production, and economic aspects of sustainability automatically takes care of social aspects: "Intrinsic to these [agroecology] projects is the conviction that, as long as the proposed systems benefit the environment and are profitable, sustainability will eventually be achieved and all people will benefit." Altieri has noted that, without intervention on policy, research, and other levels, technology developed in the name of sustainability merely will perpetuate and enhance the current differentiation between those members of society who benefit from agriculture and those who do not. Furthermore, the technology itself will not be developed and used unless we address the cultural, infrastructural, and political factors that shape how it is designed and implemented. These factors include scientific paradigms, fiscal policy, international trade, domestic commodity programs, and consumer preferences.

Limiting assumptions

To address these whole-system issues, we believe that sustainable agriculture concepts must go beyond placing top priority on environment and production practices and give greater emphasis to social issues. Although current definitions focus on environmental concerns, they are often based on two assumptions that we believe to be questionable: 1) that the farm is the primary locus for achieving agricultural sustainability, and 2) that short-term microeconomic profitability is paramount.

Farm-centric focus

Agriculture is often thought of almost purely in terms of farms and farmers, a perspective traceable to the period in which most Americans were involved in farm production but one which no longer reflects agriculture's true scope. Even though the on-farm transformation of resources into food and fiber is a core process of the food and agriculture system, it is but one of many components. The system includes not only production of agricultural products, but also their distribution and the infrastructure that affects production and distribution at regional, national, and global levels. Interactions among the larger environmental, social, and economic systems in which agriculture is situated directly influence agricultural production and distribution. The following briefly describes how these larger systems affect agriculture yet remain unaccounted for in many sustainable agriculture programs.

The environmental context. Agricultural practices ranging from the development of irrigation projects to the use of agrichemicals have often had negative environmental effects, such as wildlife kills, pesticide residues in drinking water, soil erosion, salinization, and ground water depletion. Sustainability programs often take conventional approaches to solving these problems by changing the production practices that are directly at fault, without addressing the total ecosystem context of either the problems or the alternative production practices that show promise as solutions. An example is the current emphasis on input substitution. For example, most projects funded by the USDA Low-Input Sustainable Agriculture (LISA) program in its first two years explore how inputs that cause environmental damage or incur high costs for the farmer can be replaced by more environmentally or economically benign inputs (e.g., studies on the use of soil solarization as a replacement for methyl bromide fumigation in strawberries and on the use of cover crops to control erosion and reduce fertilizer inputs). In most cases, single components of farming systems are being analyzed, and little attempt is made to place these analyses in the context of whole agroecosystems.

Substituting environmentally sound inputs for those that are damaging is an important step. But ecological sustainability requires intensive management and substantial knowledge of ecological processes (Gliessman, 1990) and cannot be achieved merely by substituting inputs. Such substitutions need to account for their complex and long-term ecological consequences. Otherwise they may engender secondary and perhaps more serious problems in the same way that conventional solutions frequently have been shown to do. Viewing agricultural systems as true ecosystems can serve as a model for bringing the whole systems perspective to bear on social and economic issues as well.

The social context. Agriculture both affects and is affected by the larger society. Farmer production decisions, for example, determine the diversity and quality of foods available to consumers, and farm size and technologies have been associated with the economic and social vigor of rural communities (MacCannell, 1988). At the same time, society determines what is possible at the farm level. Farmers lose valuable farmland when encroaching urbanization creates zoning problems, inflates land values and generates urban pollution that lowers crop productivity. Production decisions are heavily influenced by consumer decisions. An example is farmers' voluntary discontinuation of Alar on apples. Although farmers continued to endorse the safety of Alar, they realized that this position was untenable in the face of consumer concerns.

The international scope of agriculture also plays an important role. Social and economic conditions in other countries and global food supplies can greatly affect the viability of farming in a region, as shown by how the world grain shortages of the 1970s led to enormous expansion in U.S. grain production. When foreign demand for U.S. grain subsequently declined, many American farmers' incomes fell, often to the point where debts incurred to expand production could not be paid and major social and economic dislocations in the grain belt occurred.

Efforts in sustainable agriculture are not unlike their conventional counterparts in that they tend to serve selected clientele and generally do not evaluate the social consequences of the technologies they encourage. For example, organic farming strategies are often supported because they are environmentally sound and, in terms of the prices organic foods command, are profitable for farmers. An unintended and unaddressed social consequence of this is that people with low incomes often cannot afford organic products and thus are denied access to food containing fewer pesticid

residues.

The economic context. Agriculture's reciprocal relationship with the overall economy is clear. The agricultural industry is a significant portion of the nation's economy; in 1984 about 20 percent of U.S. jobs were in some aspect of food and fiber production, distribution, or service (Browne, 1989). These workers and their industries contributed 18 percent of the gross national product. The importance and volatility of food prices have made most governments reluctant to let market forces alone set these prices. Thus, a host of institutional measures have been implemented to address agricultural prices to manage their effects on consumer welfare, public coffers, farmer income, foreign exchange, food security, nutrition, and food distribution. Such policies include commodity programs, water and reclamation programs, import/export policies, and research and extension programs. Larger economic factors indirectly affect the agricultural system, such as interest rates, trade policy and negotiations, the exchange value of the U.S. dollar, and environmental regulations.

In the context of these economic policies, agriculture is subject to nonagricultural constraints and conditions, a fact acknowledged broadly in the literature of both conventional and sustainable agriculture. Yet most research and extension programs in both conventional and sustainable agriculture do not recognize or address these macrofactors. Sustainable agriculture efforts generally concentrate on environmentally sound farm-level technologies that are economically profitable for farmers to adopt. Less commonly do such efforts address how the technologies they generate will affect or be affected by larger economic concerns in the long run.

Short-term profitability

A second assumption behind many sustainable agriculture definitions, that short-term profitability is of ultimate importance, is also problematic. We recognize that short-term profitability is important in commercial agricultural systems; clearly, if growers are to adopt sustainable agricultural practices, these must be profitable in the short run as well as the long run. The problem lies in pursuit of short-run profitability at the expense of environmental and social goals. In conventional agriculture, the drive to maximize short-term profit has meant that many pressing problems have been ignored or exacerbated. Natural resources have often been treated as expendable commodities (although they cannot be produced as commodities), and agriculture has functioned more for financial gain than for human need. The social costs of production have generally been neglected: chronic hunger, inequitable economic returns and unsafe working conditions for farm labor, possible negative health effects related to nutrition and agrichemical use, and the decline of socioeconomic conditions in rural communities associated with large-scale industrial agriculture. Subordinating social goals to economic goals may easily be reproduced in sustainability programs unless sustainability concepts address the fact that profitability and social goals are not always compatible in current economic systems.

Expanding the definition of agricultural sustainability

A useful definition of agricultural sustainability not only must acknowledge social issues as priorities equivalent to those of production, environment, and economics, but also must recognize the need for compromise between the disparate but highly interactive elements that comprise agriculture. Toward this purpose, we offer the following definition: *A sustainable agriculture is one that equitably balances concerns of environmental soundness, economic viability, and social justice among all sectors of society.* Essential to this definition is recognition of the whole-systems nature of agriculture; the idea that sustainability must be extended not only through time, but throughout the globe as well; and that it must value the welfare of not only future generations, but of all people now living and all species of the biosphere.

Moving beyond the farm and microeconomics

This sustainability concept is useful because it moves beyond emphasis on farm-level practices and microeconomic profitability to that of the entire agricultural system and its total clientele. Lowrance et al. (1986) describe a model involving four subsystems that approximates a whole-systems approach. At each level, a different set of factors is most important for sustainability: 1) agronomic factors for farm fields; 2) microeconomic factors for the farm unit; 3) ecological factors for the regional physical environment; 4) macroeconomic factors for national and international economies. Their model demonstrates that focusing on only one level of the agricultural system neglects others that are equally essential. A whole-systems perspective fosters an understanding of complex interactions and their diverse ramifications throughout agriculture and the systems with which it articulates.

This understanding is at the root of sustainability. It is particularly crucial now, when the impacts of modern industrial society are global, yet the data and analytical tools we use to assess those impacts are limited by national, disciplinary, or sectoral boundaries (Dahlberg, 1987). Our educational and research institutions tend to mirror this shortcoming (MacRae et al., 1989), with the result that the larger contexts of research questions are infrequently investigated and poorly understood. Difficulties in recognizing and resolving problems whose components are grounded in several interrelated systems are compounded by the international community's disparate, competitive political and economic systems. Nations act to promote their own priorities but affect globally shared resources and globally interdependent societies, often negatively. Although nations and other sociopolitical groups generate impacts beyond their borders, they are generally incapable or unwilling to assess and react equitably (in international terms) to the results of their actions. Crosson and Rosenberg (1989) note the inadequacy of information feedback about significant

environmental problems in modern societies, an inadequacy that characterizes feedback about social problems as well. Accounting for the system-wide implications of local actions should be a primary objective for sustainable agricultural systems. The tools to facilitate such an accounting can only be developed within a whole-systems perspective.

Including equity

The definition of sustainability offered here places a priority on broad-based equity considerations. We believe it is inadequate to exclude social justice as a priority and that there is an ethical requirement for greater equity in the agricultural system. Some have combined concern for how we treat the environment with how we treat our fellow human beings (e.g., Aiken, 1984; Douglass, 1984; Gips, 1988; O'Connor, 1989). For those focusing on the latter, it is essential to look beyond sustaining our environmental and economic ability to produce agricultural goods. It is equally important to ensure that those goods are produced and distributed in an equitable manner. A concern with these human values in agriculture involves a sweeping rather than localized concept of who constitutes "us." Typically, resource conservation is discussed in terms of its implications for farmers' profitability or our descendants' food-producing capabilities. The sustainability definition we offer does not limit equity considerations to these groups. A concern with equitable social relations in agriculture requires defining "us" in terms of all fellow humans: not only farmers and future generations, but also farmworkers, consumers, nonfarm rural residents, the poor in both our own and other countries, and others. Sustainability in this sense is framed in terms of both intergenerational and intragenerational equity. Thus, issues such as farmworker rights and inner-city hunger are as central to the goals of agricultural sustainability as soil erosion and ground water contamination.

One of the most profound challenges facing agriculture is to create a decision-making process that will resolve equity issues fairly. Such a process must assess competing interests, evaluate agriculture's costs and benefits and the recipients of each, decide fairly what the compromises must be, and recognize and encourage shared goals and common ground. In most discussions of sustainability, either environmental quality or social justice issues are emphasized, but neither can be supported wholly at the expense of the other. Nourishing humans, ensuring social justice, and providing a reasonable quality of life cannot be accomplished if agriculture's resource base and environmental constraints are neglected. Likewise, environmental considerations should not be pursued at the expense of satisfying basic human needs. An equitable agricultural system must foster a decision-making process that is truly democratic, one that identifies not only what the costs and benefits are but how to distribute them fairly among all sectors of society.

Conclusion

Many sustainability definitions, particularly those that guide applied sustainable agriculture programs, are based primarily on farm production and short-term profitability. As sustainable agriculture programs have increasingly been incorporated into long-established agricultural institutions, many have accepted the largely unquestioned intellectual assumptions and infrastructural constraints that characterize their parent institutions. This is a problem because conventional agricultural institutions have fostered many technologies and policies that are not consistent with sustainable agriculture goals (Allen and Van Dusen, 1988). For example, such institutions have contributed to concentration within agriculture, have not generally benefited agricultural labor, and have systematically failed to examine their impact on the environment, the structure of rural households and communities, and the consequences of rural resident displacement (Friedland and Kappel, 1979). To place new programs designed to address these problems in the framework that produced them is of questionable value unless steps are taken to change the nature of that framework, for it determines the way its researchers see the world, pose questions, and defin problems.

Given the conventional institutiona context of most state and federal sustain able agriculture programs, it is not sur prising that they tend to focus researc on conventional priorities such as pro duction practices and efficiency an have not yet aggressively addressed so cial and economic issues. Sustainabilit priorities--and the definitions that em body them--must be expanded to encom pass the many factors affecting produc tion and distribution as well as the large environmental, economic, and social sys tems within which agriculture functions When agriculture is viewed in a whole systems context and sustainability is de fined comprehensively, it is clear wh the current popular focus on farm pro duction practices is insufficient fo achieving agricultural sustainability. De veloping nonchemical pest managemen methods, for example, will effectively re duce pesticide use only if economi structures and policies encourage thei adoption by farmers. More importantly one cannot conclude that improved pro duction practices will transform the ag ricultural system so that it meets all envi ronmental, economic, and socia sustainability goals. Social goals must b addressed explicitly. This is why produc tion techniques such as organic farming although a likely component of a sustain able food and agricultural system, can not be thought of as synonymous wit sustainable agriculture.

We believe it is important to continu exploring the meaning of agricultura sustainability. Before an improved ag ricultural system can be developed, th biases and structures that have led t agricultural problems must be closely ex amined and concrete goals articulated based on a broadened concept of agricul tural sustainability. The definition o sustainability offered in this pape stresses the equal importance of environ mental, economic, and social goals an widens the opportunity to move beyon the narrow agricultural priorities ex pressed in the past. It is based upon th whole-systems, interactive nature of a aspects of the agricultural system-- grounding that facilitates conceivin problems and their resolutions not onl

in terms of their immediate time frames and local impacts, but, just as importantly, in terms of their future time frames and their global impacts. This definition encourages emphasis on optimum production over maximum production, the long term along with the short term, the public's best interest over special interests, and the contextualization of disciplinary work within interdisciplinary frameworks. We hope that this definition helps advance the discussion on developing a food and agriculture system that is sustainable for everyone.

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Circle of Poison bill introduced in Senate

U.S. Senator Patrick Leahy of Vermont and U.S. Representative Michael Synar of Oklahoma have introduced a "Circle of Poison" bill which would prohibit the export of pesticides that are not registered for domestic use or have a food tolerance, are not registered for food use and would be exported for use on food, or have had the majority of registrations canceled. The IAA is among the many supporters of the bill, which would also permit governments of importing countries to refuse the import of "particularly hazardous pesticides," based on health and environmental concerns.

Under this bill, citizens would be permitted to file suit against violators of the statute to enforce its provisions, and tolerances for pesticide residues on food for pesticides no longer registered in the United States would be revoked.

The Circle of Poison bill is similar to a bill introduced last year, which had the support of 67 national and international consumer, environmental, farm, labor, and regligious organizations. A campaign is now under way to get similar support for this year's bill.

New surveys analyze federal grading system, consumers on food safety

Federal grading standards for the appearance of produce are a barrier to reduced pesticide use and stifle markets for organically grown produce, according to a new survey of retailers, wholesalers, and growers by Public Voice for Food and Health Policy. Though many of the retailers and wholesalers questioned require produce to have no blemishes or less than 1 percent blemishes, more than half believed consumers would buy produce with more blemishes if they knew fewer pesticides had been used to grow it. Another survey found that consumers would pay higher prices for produce in exchange for guarantees that pesticide residue levels met or were lower than federal standards. Consumers are still greatly concerned about pesticide safety and uncertain about the standards now applied to food, according to the survey done by researchers at Michigan State University.

Agroecology. Researching the Ecological Basis for Sustainable Agriculture. 1990. Edited by Stephen R. Gliessman. Springer-Verlag, New York, New York. 380 pp. $89.00, hardbound.

Agroecology. 1990. Edited by C. Ronald Carroll, John H. Vandermeer, and Peter M. Rosset. McGraw-Hill, New York, New York. 641 pp. $89.95, hardbound.

Agricultural Ecology. 1990. By Joy Tivy. Longman Scientific and Technical, Harlow, Essex, England (copublished in the United States with John Wiley & Sons, Inc., New York, New York). 288 pp. $34.95, softbound.

Agroecology is still at the stage in which authors and editors feel obliged to define what it is before they talk about it. The three books reviewed here all attempt to delimit agroecology or give an overview of its major topics. The common ground of definitions is the fusion of ecology with agricultural sciences. This allows ecological methods and theoretical insights, often developed with non-economic species occurring in natural communities, to be applied to agricultural phenomena. Frequently, agroecology is assumed to be strongly linked to sustainable agriculture. Agroecology is supposed to be the science that will provide the knowledge required to achieve and quantify agricultural sustainability. Looking at these three books together helps us identify what agroecology can deliver, beyond promise, and what is missing from current conceptions. These questions are important if agroecology truly is the scientific base from which to make agriculture more sustainable.

The first book is the most ambitious in its aims. The editor believes that the challenge for agroecology (and this book) is to "find a research approach that consciously reflects the nature of agriculture as the coevolution between culture and environment, both in the past and the present" (page 8). Therefore, the field should involve "the integration of ecological and cultural knowledge" (page 10). The purposes of the second book are more modest: to provide an overview and introduction to agroecology and "a critical attitude with regard to both the scientific and sociopolitical aspects" of agroecology (page xii, Preface). At the other end of the spectrum, Tivy does not claim to be either comprehensive or definitive, but merely hopes to interest "students of whatever agricultural and/or environmental persuasion" (page v, Preface).

The first two books continue a style of agroecology that began, according to Gliessman, with Cox and Atkins's 1979 book *Agricultural Ecology*. Both books include a section on the biological or ecological principles underpinning agriculture and several examples of specific management problems that call for an agroecological approach. Carroll et al. also includes a section on agricultural research, plus background material on the history, geography, sociology, and environmental impacts of agriculture. Tivy has much less background material and dives immediately into components of agroecosystems and agriculture in specific climatic zones.

A strength of both Gliessman and Carroll et al. is that they integrate contemporary ecological work and agricultural production sciences with discussions of the environmental effects of agricultural processes. Both books have fine examples of the kinds of contributions agroecology can make. In contrast, the failure to merge ecology, agricultural sciences, and environmental science is a serious flaw of Tivy's book, reducing it to little more than a general introduction to worldwide agricultural production. Tivy ignores se vere environmental problems until th final chapter, "Agriculture and the En vironment." For example, on page 8 she describes "waste" of nutrients a a problem merely because of reduce efficiency of fertilizer use and lowere productivity, with no mention of th environmental consequences of thos "wasted" nutrients ending up in inap propriate places.

Tivy's view of agroecology is exces sively constricted, but the catholic per spective of Gliessman and Carroll et a has its own problems. Both books hav a very broad scope, ranging from th technical details of intercropping to so cial relations of agriculture. Such open ness is refreshing--ecologists an agronomists have too frequentl shunned the social implications of thei science--but it needs to be coupled wit more discrimination than is evident i these books for agroecology to have co herence and direction.

Lack of focus crops up especially i Parts 1 and 4 of Carroll et al. For exam ple, only one of the four chapters i Part 4, "On Agricultural Research," deals specifically with agroecology. Al though some individual papers in thes parts are interesting and well written the extraneous material bogs down th treatment of relevant topics. The fuzz focus also leads the editors and author of both Gliessman and Carroll et al. t include social problems that agroecol ogy cannot reasonably address (e.g. "the agroecological approach focuse on the system as a whole with an ey toward the multiple goals of productiv ity, profitability, reduced uncertaint and vulnerability, equity, protection o the health of producers and consumers environmental protection, and long term sustainability and flexibility," (Levins and Vandermeer, page 342 i Carroll et al.). These are all worthwhil goals, but some are in the realm o politics and social sciences, not intrin

sic to agroecology. Including such a diversity of disciplines and hence methods under the heading of agroecology passes over the question of whether it can be a single field or the "research approach" Gliessman hopes to establish, or merely a gathering of topics related to agriculture.

There is a fundamental confusion in both Gliessman and Carroll et al. about how humans should be included in agroecological analyses. The vision of agroecology promoted by Gliessman is "more than just ecology applied to agriculture. It takes on a cultural perspective as it expands to include humans and their impacts on agricultural environments" (page 369). The possibility of linking the study of social forces and environmental processes is immensely exciting. Gliessman, Carroll et al., and their contributors deserve credit for recognizing critical social causes of agriculturally related environmental degradation. But there is a wide gap between recognizing and analyzing.

Human culture requires very different methods of analysis than ecological phenomena. Ecology's methods were designed to study organic processes and the behavior of organisms that lack most forms of intentionality. Human capacity for intentional action--our abilities to use indirect strategies, to learn from mistakes, to delay gratification, to persuade others to work collectively--imposes a layer of complexity that is qualitatively different from that of the naturally occurring "societies" that ecological methods can study. The mechanism of reproductive advantage that explains much animal behavior is lacking in human societies. This means that human behavior and the behavior of animal populations require fundamentally different types of explanation (for a full discussion of differences in types of explanation, see Jon Elster, 1983, *Explaining Technical Change*, Cambridge, Cambridge University Press).

Tension over whether the study of human societies should be part of agroecology pervades both books. There is almost no social analysis (i.e., explanations of why people and societies behave as they do). This is hardly necessary for most of the topics considered, yet many of the authors seem uncomfortable with its lack. For example, the final sentence of a chapter about whether polycultures have lower insect pest densities reads, "A socioeconomic perspective should parallel the biotechnical investigations" (Altieri et al., page 80 in Gliessman). Yes, but this is outside the domain of agroecology.

The social analysis that does get in is problematic. For example, in one paper the traditional or "precapitalist" farmer is assumed always to be "rational and efficient" and "intelligent and reflective" (Deo and Swanson, pages 586-587 in Carroll et al.). These assumptions spring from particular political interpretations of events and motives, most evident and obtrusive in Part 4 of Carroll et al. Deo and Swanson's chapter on agricultural research in developing countries is especially loaded with political code words, questionable assumptions, and imputations of conspiracy to oppress the Third World. Their arguments may well be true, but they have no special relevance to agroecology.

An additional problem marring several articles in the first two books is a level of abstraction that is excessive for qualitative or speculative relationships. Sometimes this is manifest in inappropriate theorizing and use of mathematics and sometimes in allowing data-collection technology to take precedence over common sense and direct observation. For example, "visual symptoms should not be ignored" in detecting crop water deficits or selecting drought-resistant genotypes, but they are discussed after paragraphs on the pressure chamber, acoustic emissions, and the infrared thermometer (Hall, page 221 in Carroll et al.). As another example, the factors for deciding which crop to plant in an area include soil protection and buildup, indirect contributions to pest control, and microclimatic effects; but they do not include such obvious things as soil types and what farmers have experience cultivating (Levins and Vandermeer in Carroll et al.).

A final conceptual problem evident in the Gliessman book is the way agroecology has been relegated to systems ecology, with generalizations about the whole field that are only true for systems studies. For example, "through the application of ecological concepts and principles to the design and management of agricultural systems, a holistic perspective is established" (page 367). Much work in agroecology, including research reported in this book, is not holistic at all. It could be argued that ecology's concepts and principles are least well developed for whole systems, so that this may not be the most fruitful area for combining ecology and agriculture.

There are other more specific problems in the first two books. They are priced out of range for textbooks or most personal libraries. One article (by Pimentel, Dazhong, and Giampietro) appears in almost exactly the same form in both volumes, with no note that it has been published twice. The papers in Gliessman's book are uneven in their level of detail. A few are quite superficial, while others are excessively detailed. In both books, some papers have few ecological concepts, or the "agroecological" overview draws little from ecology that is not already entrenched in the agricultural approach to a topic. How much of agroecology is simply claiming and renaming fields that are moving along quite well without an explicit infusion of ecology?

All three books have frequent misspelled or inaccurate references, and errors in figures, graphs, and equation notation (e.g., Vandermeer redefines parameters within the equations on pages 354-355 in Carroll et al.). These distract readers from the real contributions of the first two books, but the level of these kinds of errors is no higher than is common in recent technical books on agriculture. In contrast, Tivy's book contains an unacceptable number of errors due to sloppy editing. Almost every species list has at least one wrong genus or species. This is more troubling than common typographic errors because the whole point of scientific nomenclature is to provide a consistent, internationally recognized system. Common and chemical names also do not fare well; triticale becomes

"tricale" (page 13), and 2,4-D appears as "2.4D" (page 229). There are far too many figures and tables, often more than one per page and almost always taken from other publications. Borrowed figures and tables often contain excessive abbreviations, lack sufficient explanation in the text, or are inappropriate to illustrate the point they are supposed to show.

There also are too many factual errors in Tivy's book. For example, we learn that the three major grains are maize, sorghum, and millet (page 14) rather than wheat, rice, and maize; that typical C/N ratios for organic matter in cultivated and unmanaged soils are 1:12 and 1:20 (page 65) rather than 12:1 and 20:1; that grass productivity data for rangeland are unavailable (page 126); that livestock play a relatively minor part in dry-farming agriculture except in South Australia (page 200); and that the use of zero tillage in the U.S. is for seeding maize into a ley (page 231). The book is riddled with problems like these. Having this many errors interferes with the basic trustworthiness an author must establish for a book to be useful. An additional problem is Tivy's reliance on outdated references, which is egregious in such a rapidly expanding field. I found only 5 percent of the 565 total references to be later than 1985.

In sum, these three books are disappointing. There is no question that ecology and agricultural sciences can be mutually beneficial. The failure of agriculturists and ecologists of the last half century to work in collaboration has been detrimental because theoretical work in ecology generally has not been matched in agricultural sciences and because agricultural systems can provide a controlled environment for testing and refining these theories. The first two books have moments of insight in which ecological methods are used to test and explain why some observed phenomenon occurs, then to suggest improvements in agricultural systems. But the theme of agroecology's unique assets is not sustained clearly enough through the chapters.

Some of the authors in Carroll et al. (e.g., Weiner; Power and Kareiva) have considered precisely what ecology can contribute to their particular fields of expertise. At agroecology's incipient stage, this is a useful exercise; it needs to be done for the field as a whole, as well as for subtopics. In the final chapter of his book, Gliessman argues for an "interface" between our understanding of ecosystem processes and the social, economic, and political systems within which agroecosystems function. We need a better understanding of what will comprise that interface, with the clear recognition that ecology's present methods cannot be used to analyze human social phenomena.

Given its constituent sciences, agroecology's most meaningful contribution probably will be toward understanding the interactions of various agricultural processes with the biological and physical environments. Applying ecological methods to agricultural systems promises to give useful results, but we will meet this challenge faster if we prune back the aims of agroecology to understanding what makes the tangible aspects of agricultural systems work, rather than trying to tackle cultural systems as well. Agroecology would benefit if we could be content with "just ecology applied to agriculture"--this is not a goal to belittle. -- *Molly D. Anderson, Research Assistant Professor, School of Nutrition, Tufts University, Medford, MA.*

Agricultural Bioethics: Implications of Agricultural Biotechnology. 1990. Edited by Steven M. Gendel, A. David Kline, D. Michael Warren, and Faye Yates. Iowa State University Press, Ames, Iowa. xxiv, 357 pp. $34.95, cloth.

Rarely do I find intellectual gratification in reviewing a symposium volume. The quality of the contributions is often uneven. The organization of the work is somewhat arbitrary and usually determined ex post facto. Delays in publication are commonplace, and there is a great tendency toward recycled ideas. Although this volume shares some of these characteristics, overall it is several levels above the run-of-the-mill collection of papers. The volume is well edited, the contributions are timely, the essays are scholarly, and the book's typeface and design are appealing. Of its 22 essays, a high proportion make important contributions to the ethical and policy discussions of current biotechnological developments in agriculture. For one or two policy issues, it is the best collection available.

It is noteworthy that the book was partially funded by the Iowa State Legislature, which set aside a portion of its biotechnology appropriation for the study of social and ethical issues. There is very little precedent for a "tithing of research" to examine its impacts on society, but we are beginning to see it for biotechnology. Congress, too, has set aside a small percentage of funds appropriated for the Human Genome Initiative to examine the social and ethical dimensions of the research and its consequences. Iowa State University has been a leading institution in examining the complex problems of agricultural innovations through biotechnology.

The guiding theme throughout this work is: What contributions will biotechnology make to the future development of agriculture and what values are at stake in the anticipated changes? One issue which is covered by most of the essays in the work either directly or indirectly is the problem of bovine growth hormone (bGH). Had the symposium and the book been organized around this theme exclusively, it might have been more coherent. I shall use the bGH theme as a way of examining several of the contributions to this volume, but there are several other themes that I do not discuss in this review.

The issue in question is whether bovine growth hormone (also called bovine somatotropin), manufactured by recombinant DNA techniques, should be administered to cows to increase milk yield. From the regulatory standpoint, the problem is well defined. BGH is a veterinary drug, and the sole issue is whether it will compromise the quality of milk or harm the consumer. But that is just the starting point for the social analysis that this volume ad-

dresses. This product, which stands to be the first significant agricultural product of biotechnology, has turned out to be a lightning rod for a host of issues that address the future of the post-industrial farm. Prominent among these is whether bGH will accelerate the decline in small farms.

Industry spokespersons claim that bGH is scale neutral, so that small and large dairy farmers will benefit equally. Many popular writings on the subject end at that point. Since each cow must be injected, if the price of an injection is fixed, it follows that there is no large farm advantage. This book shows us how easily it is to be misled. The political economy of scale advantage is much more complex than it appears. Barnes and Nowak's contribution discusses several factors involved in the use of a bGH regime, including increased feed, more managerial skills such as record keeping, monitoring and testing, and access to more labor. Their conclusion, based on a survey of 270 dairy farmers, is that bGH is designed to be used most efficiently by the highly capitalized growth-oriented farm. Kliebenstein and Shin summarize other research and reach a similar conclusion that "farm operations with below-average management and below-average production levels will likely lose."

Jack Doyle, already a true believer that bGH is no friend to small farmers, argues for a public sector role in improving profitability through low-input sustainable agriculture. Doyle believes that such changes can be made by redirecting land grant research agendas. Ironically, bGH is a case where that would not have mattered. The research was almost wholly funded by the corporate-agricultural sector. Land grant institutions and field stations served only to evaluate the product's efficacy. Doyle makes a persuasive argument for the necessary but not the sufficient conditions for establishing a new agricultural agenda.

Fred Buttel is a leading scholar on the effects of biotechnology on agriculture. His essay tackles the larger picture of bGH's role in shifting the political economy of the farm. Buttel casts bGH as one of many contributions to structural change in the agricultural sector; it is not revolutionary, but neither is it trivial. The *raison d'être* of bGH is economic efficiency, pure and simple. Buttel concludes that it requires more capital and management, increases output, and supports the increased concentration of the dairy industry. The chorus of agreement on these issues is growing stronger. But what can be wrong with those values, since that is what brought us to our current position? Several other essays tackle this issue in terms of preserving the family farm, promoting sustainable agriculture, or reevaluating the distribution of agricultural income.

In this essay, more than in his other work, Buttel softpedals the qualitative and therefore deeper changes that biotechnology offers to agriculture. "To the degree biotechnology is unique...this uniqueness is more a function of its social relations than of its biology." In my view, there are technological advances in microbial protein synthesis that may radically change the way certain crops are produced. At issue is whether sunlight, water, and soil will be replaced by microbes, recombinant DNA, feedstock, and fermenters as the fundamental basis of food manufacture. There is far more at stake than a marginal change in agricultural productivity. The ultimate biotechnological solution to the dairy farm is to produce milk exclusively through a bacterial process. The issue of scale neutrality gets turned on its head (or its herd) when the cow is eliminated from milk production.

The essays by Gary Comstock and B. E. Rollin offer another dimension to the debate over bovine growth hormone, namely, the ethics of animal use. Rollin asks: "Will bGH help alleviate the trend toward treating dairy cattle as nothing more than milk machines on legs?" He argues that animals have legitimate interests that must be considered even when they are used for human purposes. These interests, according to Rollin, derive from the animal's telos, the set of physical and psychological needs central to the animal's existence. Others have used the term "species nature" to express the same idea. Rollin proposes as a minimal principle that any new intervention should not make the animal suffer more than it does at the present. The morally correct treatment of animals is to reduce or eliminate the "friction between telos and environment."

Food animals are so inbred, their phenotype so adapted to human requirements, that it hardly makes sense to speak of the animal's telos apart from its commercial use. Rollin, however, believes that one can evaluate the quality of life of mammals through physiological and behavioral signs of stress. His position differs from the hard core "Don't tamper with nature" contingent, who view transgenic animals or other interventions such as bGH as inherently immoral. Applying Rollin's principle to the bGH case, one would have to evaluate whether the cow's comfort or physical state is harmed by the drug, for example by increased mastitis.

Comstock's essay "The Case Against bGH" is an excellent, although partisan, review of the entire issue. He expresses the frustration that is felt on both sides of this debate.

It is my intuition that the Wisconsin farmers are right: something about bGH's social and economic effects is objectionable. On examination, however, I have found it very difficult to say exactly what that is. No laws have been broken, no contracts circumvented, no federal regulations ignored.

The critics of bGH are trying to set the ground rules of the debate because they view the traditional role of technology assessment as favoring the mega-agri-industrial systems. BGH and biotechnology are simply the latest vehicles through which fundamental issues of new agricultural technologies are being raised in public debate. The book is very successful in covering the issues as long as one is not looking for a point-counterpoint approach or equal time from the biotech development sector. -- *Sheldon Krimsky, Professor, Department of Urban and Environmental Policy, Tufts University, Medford, MA.*

Producers and Practices of Sustainable Agriculture in the Southern Rockies is a directory for those reducing their dependence on farm chemicals and expanding their crop variety, published by the Sustainable Mountain Agricultural Alliance (SMALL). Copies are $10; contact The Telluride Institute, P.O. Box 1770, Telluride, CO 81435; (303) 728-4981.

The State of U.S. Organic Producer Marketing Cooperatives in 1990 is a working paper from the U.S. Department of Agriculture's Agricultural Cooperative Service. Contact Alan Borst at USDA/ACS, P.O. Box 96576, Washington, DC 20090-6576; (202) 245-5399.

Integrated Farm Management Demonstration Program 1990 Progress Report covers work conducted by Iowa State University with participating farmers on ways to protect water quality through improved farm management. Copies are $2; contact Extension Publications Distribution, 103 Morrill Hall, Ames, IA 50011-2170; (515) 294-5247.

Sustainable Agriculture Packet from Iowa Citizens for Community Improvement includes a sourcebook of steps and strategies for cutting chemical use; a source list; a booklet, "Switching to a Sustainable System" and two farmer-to-farmer directories about more than 80 Iowa farmers. Price is $7 for Iowa farmers and Iowa FFA members, $15 for others; contact Iowa CCI, 1607 E Grand, Des Moines, IA 50316; (515) 266-5213.

Integrated Pest Management in Agriculture, a 29-minute video, is available for $75, plus $3 shipping and handling, from San Luis Video Publishing, P.O. Box 4604, San Luis Obispo, CA 93403; (805) 545-5426.

The 1989 National Research Council book, *Alternative Agriculture*, is available for $5 from the USDA Extension Service. Contact Dr. Jim Bushnell, USDA Extension Service, 3341 South Building, Washington, DC 20250-0900; (202) 447-4341; FAX: (202) 447-4924.

1991 National Directory of Organic Wholesalers is available from California Action Network for $29.95 (plus $5 for shipping and handling), with $2 off if this newsletter is mentioned. Mail orders to CAN, P.O. Box 464, Davis, CA 95617; call 1-800-852-3832.

National Herbicide Use Database contains estimates of use for 96 herbicides on 84 crops in the late 1980s, available on national, state, and local levels, with varying prices. Contact Resources for the Future, 1616 P Street, NW, Washington, DC 20036; (202) 328-5025.

1990 Sustainable Agriculture Demonstration Grant Program Results is available from the Illinois Department of Energy and Natural Resources. Contact Deborah Cavanaugh-Grant, ENR, 325 W Adams, Springfield, IL 62704; (217) 785-8582.

Soil Management for Sustainability, a 189-page book of 14 manuscripts presented at a conference, is available for $15 from the Soil and Water Conservation Society, 7515 NE Ankeny Road, Ankeny, IA 50021-9764; call toll-free, 1-800-THE-SOIL.

Seed to Seed, a 222-page seed saving guide for 160 vegetable crops, is available for $20 from Seed Savers Exchange, Rt. 3, Box 239, Decorah, IA 52101.

Robert Parnes Speaks on the Science and Necessity of Organic Residues in the Soil is a 60-minute video about plant nutrients and organic matter. Copies are $29.95; contact Peter Griesinger, Griesinger Films, 7300 Old Mill Road, Gates Mills, OH 44040; (216) 423-1601.

Composting Potato Culls and Potato Processing Wastes is a report on a composting project in Fort Fairfield, Maine. Contact the Woods End Research Laboratory, Old Rome Road, Rt. #2, Box 1850, Mt. Vernon, ME 04352; (207) 293-2457.

On-Farm Research: Summary of 1990 Results and **Methods for Screening Soil-Improving Legumes** are available from New Farm Library, Rodale Institute, 222 Main Street, Emmaus, PA 18098. "On-Farm," 65 pages, is $7.95; "Methods," 340 pages, is $24.95.

Toward a Sustainable Agriculture: A Teacher's Guide, a high school curriculum prepared by the Sustainable Agriculture Curriculum Project, costs $10 from the Wisconsin Rural Development Center, 1406 Bus. Hwy. 18-151 East, Mt. Horeb, WI 53572; (608) 437-5971.

Sustainable Agriculture Practices for Field Crop Production in the Northeast, a 12-minute video, is available from Cornell University Resource Center, Rich Gray AV Division, 8 Business and Technology Park, Ithaca, NY 14850.

Sustainable Agriculture for California: A Guide to Information, published by the University of California, is available for $12 payable to UC Regents from ANR Publications, University of California, 6701 San Pablo Avenue, Oakland, CA 94608-1239; (415) 642-2431.

Organic Weed Control, a 30-minute video, is available from Natural Organic Farmers Association, RFD #2, Barre, MA 01005. A list of 50 other videos is also available from NOFA.

Alternative methods can greatly reduce pesticide use, says report

Alternative farming techniques could reduce pesticide applications between 25 and 80 percent on nine crops grown in California and Iowa, according to "Harvest of Hope," a new report by the Natural Resources Defense Council. Those reductions can be achieved with available technologies, many of which have been implemented on farms without reducing crop yields or raising production costs.

The report documents the extent of water contamination by agricultural chemicals and identifies crop-specific alternative farming methods that could dramatically reduce the use of pesticides. Also examined are many of the policy barriers farmers face in adopting alternative practices, including the lack of federally supported research for alternative farming systems, and the federal farm programs' penalizing of crop rotation, an effective way to reduce chemical inputs and increase crop yields. Federal and state marketing policies and grade standards also place a premium on the cosmetic qualities of produce that can most easily be achieved with high chemical use.

"Pesticide contamination of the food supply, farmworker illness, ecosystem degradation, and now water pollution have all resulted from agricultural pesticide use, much of which can be eliminated with alternative farming practices," said Lawrie Mott, an NRDC scientist and co-author of the report. For more information, contact NRDC, (415) 777-0220.

INSTITUTE NEWS

Institute inaugurates Visiting Scholar Program

The IAA's new Visiting Scholar Program was inaugurated in June with the arrival of David Watt, an Associate Professor of Agricultural Economics at North Dakota State University in Fargo, North Dakota. He is spending ten weeks at the IAA studying the responses and contributions to agricultural sustainability of institutions such as the USDA and the EPA. Watt is one of the nation's leading farm management professionals, particularly in strategic planning and financial risk management. He is the Executive Secretary of the Northwest Farm Managers Association, which brings together farmers, university staff, and business leaders to support the state's agriculture. Raised on an Iowa farm, Watt studied at the University of Missouri, earned a Ph.D. degree in agricultural economics from Michigan State University, and worked for the USDA's Economic Research Service before moving to North Dakota.

In the early fall, the IAA expects to invite people interested in being Visiting Scholars to submit proposals for 3-6 month projects dealing with the effects of national and state policies on adoption of sustainable agriculture, conceptual issues, sustainable agriculture curriculum development, international dimensions of sustainability, and institutional issues.

IAA report examines research on likely impacts of sustainable agriculture

A new IAA publication reports that little research has been done on the likely impacts of widespread adoption of a sustainable agriculture and that what has been done tends to have serious limitations. The publication, *An Agenda for Research on the Impacts of Sustainable Agriculture,* Occasional Paper Series Number 2, released July 1991, says that contemporary research is basically incompatible with the meaning and nature of sustainable agriculture as it is commonly defined.

Those are the findings of a panel of eight leading social scientists, as interpreted and summarized by Neill Schaller, IAA's Associate Director and panel moderator. The group, including agricultural economists and rural sociologists, was convened by IAA in early 1991 to examine the state of research on the implications of sustainable farming in the U.S. and to recommend ways to overcome its limitations.

The panel members were: Frederick H. Buttel, Cornell University; Paul Faeth, World Resources Institute; William D. Heffernan, University of Missouri; Glenn A. Helmers, University of Nebraska; Stanley R. Johnson, Iowa State University; Linda K. Lee, University of Connecticut; Kent D. Olson, University of Minnesota; Katherine Reichelderfer, Resources for the Future; Neill Schaller, IAA (moderator).

The report identifies three ways in which contemporary research is ill-suited to the task of estimating the impacts of sustainable agriculture:

The "indicators" used by researchers to describe the impacts of sustainable farming overemphasize agricultural performance--through measures such as production, exports, and food prices--and fail to depict the range and the interplay of environmental, health, and socioeconomic impacts of interest to the public. Indicators simply do not exist to characterize impacts such as the effects of chemical-intensive farming practices on farmers' health.

Current research methods and assumptions typically overlook or fail to describe realistically the full meaning of sustainability and the holistic nature and complexity of sustainable farming approaches.

The research community's lack of familiarity with sustainable farming systems often leads to unrealistically low estimates of crop yields on farms adopting sustainable practices.

The panel report urges the agricultural research establishment--especially agricultural economists and rural sociologists--to create new indicators that will effectively portray the range of public interests in sustainable agriculture; to develop innovative research methods and assumptions that will be compatible with sustainable farming and adequately describe and measure its impacts; and to design and test new ways of estimating the yields that can be expected when farmers shift to sustainable farming practices.

As limitations of contemporary research are due both to the way contemporary research has been carried out and to shortcomings in the analytical tool kit, the report says that "what is needed first and foremost is a fundamental change in the philosophy and mindset of those who administer and conduct the Nation's agricultural research."

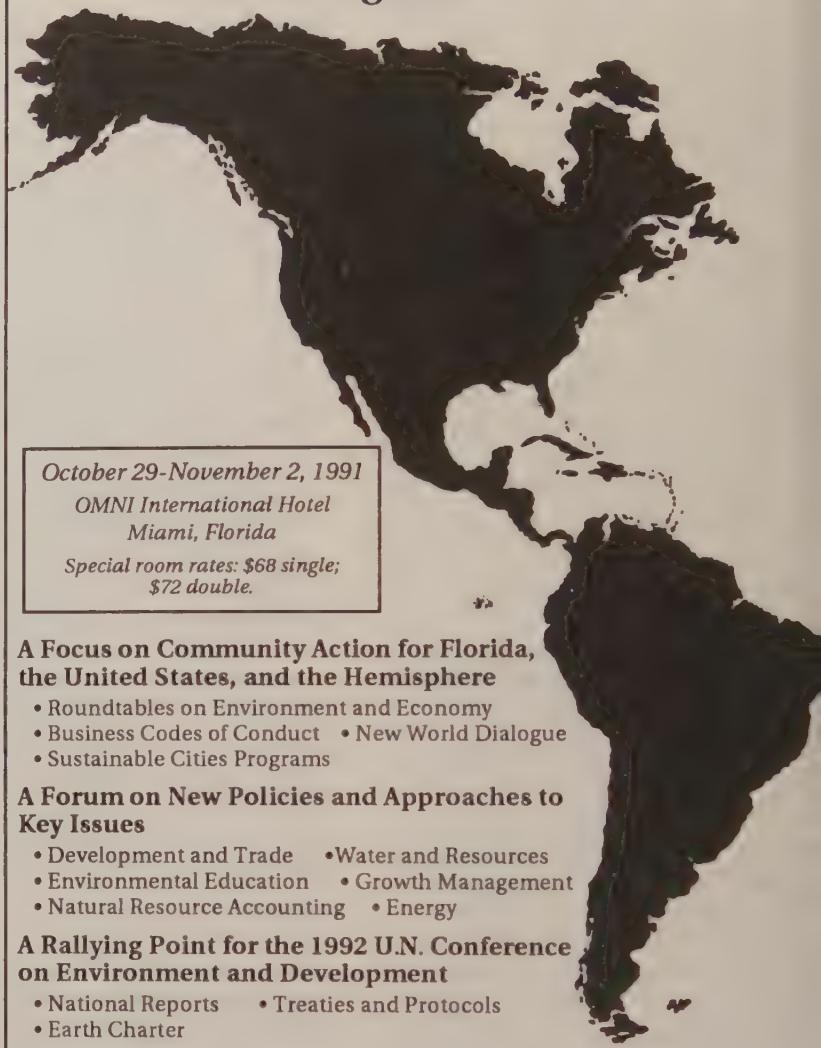
Copies of *An Agenda for Research on the Impacts of Sustainable Agriculture* are available free from the Institute for Alternative Agriculture, 9200 Edmonston Road, Greenbelt, Maryland 20770 (phone 301/441-8777).

LETTERS TO THE EDITOR INVITED

The AJAA welcomes letters, short or long, commenting on articles in this journal or sharing ideas likely to be of interest to other AJAA readers. Since our space is limited, we do reserve the right not to publish all letters or, at times, to publish only excerpts from them. To take part in this exchange of ideas, write to: Editor, AJAA, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770.

Globescope Americas

Charting A Sustainable Future



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UPCOMING EVENTS

August 18-21. 2nd Conference on Agroforestry in North America will be held at the Holiday Inn University Plaza, Springfield, Missouri. Contact University of Missouri, University Extension Conference Office, 348 Hearnes Center, Columbia, MO 65211; (314) 882-2429.

Now through October. Sustainable Agriculture On-Farm Research and Demonstration Program 1991 Field Days, sponsored by the Minnesota Department of Agriculture, are being held several times a week throughout the state. Contact Doug Gunnick, David Ball, Energy & Sustainable Agriculture Program, 90 West Plato Boulevard, St. Paul, MN 55107; (612) 296-3820.

September 5-6. Eighth Annual Field Days at the Thompson Farm in Boone, Iowa. Contact Rodale Institute, 222 Main Street, Emmaus, PA 18098; (215) 683-6383.

September 13 through May 19, 1992. Nine agriculture short courses will be sponsored by the University of Florida Cooperative Extension Service. Contact Agriculture Center, 250 W County Home Road, Sanford, FL 32773; (407) 323-2500, ext. 5559.

September 14-15. New Jersey Organic Country Fair is sponsored by the Natural Organic Farmers Association of New Jersey. Contact John Canright, (201) 356-9498.

September 20-22. Common Ground Country Fair, sponsored by the Maine Organic Farmers and Gardeners Association, will be held at Windsor Fairgrounds, Windsor, Maine. Contact the Association, P.O. Box 2176, Augusta, ME 04338; (207) 623-5115.

September 20-22. 1991 Seeds of Change Conference, sponsored by Gila International Center of Diversity, will be held in Santa Fe, New Mexico, and focus on bioremediation and biodiversity. Contact Gila, 621 Old Santa Fe Trail #10, Santa Fe, NM 87501; (505) 984-1338.

September 28-29. Farm Heritage Festival, sponsored by Maryland National Capital Park and Planning Commission, will be held at Prince Georges Equestrian Center, Upper Marlboro, Maryland. Contact Barbara Kern, (301) 249-7077.

October 5-10. Farming Systems Research and Extension in the 1990s: Critical Issues and Future Directions, sponsored by the Association for Farming Systems Research-Extension, will be held at Michigan State University in East Lansing. Contact AFSRE, Institute of International Agriculture, MSU, 324 Agriculture Hall, East Lansing, MI 48824; (517) 353-5262.

October 6-9. New Crops: Exploration, Research, Commercialization, sponsored by the Department of Horticulture, Purdue University, West Lafayette, Indiana, will be held at the Hyatt Regency Hotel, Indianapolis, Indiana. Contact Kathy Hyman at Purdue, (317) 494-2758.

October 29-November 2. Globescope Americas: Charting a Sustainable Future, sponsored by Global Tomorrow Coalition, will be held at the Omni International Hotel in Miami, Florida. Contact John McKain at the Coalition, 1325 G Street, NW, #915, Washington, DC 20005; (202) 628-4016.

November 10-13. International Conference on Agriculture and the Environment, sponsored by Ohio State University, will be held at the Holiday Inn, Columbus, Ohio. Contact Dr. Clive Edwards, Department of Entomology, OSU, 1735 Neil Avenue, Columbus, OH 43210; (614) 292-3786.

November 21-22. Conference on Innovative Policies for Agricultural Research to be held in Boston, MA. Conference themes include needed changes in the professional and institutional setting for the conduct of alternative agricultural research. Contact William Locheretz, School of Nutrition, Tufts University, Medford, MA 02155.

"On-Farm Research Techniques" report available from IAA

"On-Farm Research Techniques," the first in IAA's Occasional Paper Series, is a report from a workshop organized last November to discuss how on-farm research can contribute to minimizing farming-related environmental and social problems. As interest in research on alternative agricultural systems has increased, disparate ideas have emerged about what on-farm research can accomplish, when it is appropriate, and how to do it properly. In addition to reviewing research techniques, this paper examines such important issues as farmers' research versus researchers research, on-farm activities that complement research, appropriate choices of farms to be studied, collaborations among many groups of people with diverse interests, and barriers to acceptance of on-farm research.

The report was prepared by Molly D. Anderson and William Lockeretz of the School of Nutrition at Tufts University, Medford, MA. Copies are available for $6.00 from IAA, 9200 Edmonston Road, #117, Greenbelt, MD. 20770

Continued from page 2

upon which a foundation of sustainable development can be built—it can provide insight into both the capabilities and limitations of the natural and human resource. Assessment of the current natural/human resource base (e.g., *via* "Rapid Appraisal" or Hildebrand's (1981) "Sondeo") further reveals the foundation upon which a sustainable economy can be based. Next it is essential that some flexible ground rules be established as to the boundaries, structure, goals, and policies under which the community will function. Finally, the community must develop the capability of measuring sustainability, which includes indicators of local socioeconomic conditions, succession, mineral cycles, water cycles, and energetics, to determine if they truly are on the road to sustainable development. If a process such as this doesn't take place, we will continue to be entrapped and bogged down with "the end justifies the means," "technological fix," "it's the public perception that counts," "they're the bad guys," "those terrible, nasty chemicals," and other unhelpful rigidities that have plagued past efforts to deal with an ecological approach to whole systems living.

Until recently, we generally have referred to our efforts as conservation and sustainable *rural* development (CSRD) and often will continue to do so. However, use of the word "rural" may distract from the necessary partnerships required for a truly sustainable agriculture, which include partnerships between cities and the country, between farmers/ranchers and urbanites. A rural community includes basic biotic, soil, air, water, and energy resources from which local townspeople and farm/ranch workers, managers, and owners derive their living. It encompasses not just farming, ranching, and "natural" systems relatively untampered with by humans, but also urban communities. For example, Odum and Odum (1987) showed that, in Texas, industries based on agricultural products constitute 33 percent of the Texas economy. They pointed out that "many people who live in the cities are really part of the farm-based economic system but don't realize it." Krupicka et al. (1988) further discussed implications of conventional usage of the term "rural" and stressed that USDA analysts seriously underestimate the importance of agriculture to communities.

Nevertheless, because we believe that effective dialogue, trust, partnerships, and team building are so important in moving toward a sustainable economy, we have replaced the word *rural* with the more generic term *community*. We are certain that a spirit of community involving cooperation, leadership development, consensus building, and empowerment of the poor is essential for advancing toward relatively sustainable systems.

Similar processes are being developed and utilized by World Neighbors, Appalachia-Science in the Public Interest, the Uganda Rural Development and Training Program, Coordination in Development, Inc., Volunteers in Technical Assistance, and the Latin American Consortium on Agroecology and Development (CLADES). These processes are founded on communication and goals and bring people together to achieve a better quality of life. We believe that such a process is essential for developing policies and strategies supporting long-term sustainability.

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EPA may ban pesticide

EPA scientists have recommended banning the sale of parathion, one of the most poisonous pesticides used in American agriculture. It is used on fruits, vegetables, nuts, and grains, and has poisoned more than 650 field workers since 1966, of whom at least 100 have died. New studies show that parathion could be a hazard to people and wildlife at a distance from farms because it drifts in the air and can linger in fog. Trace amounts may be ingested by consumers because of residues on vegetables. EPA will decide soon either to ban all of the pesticide or just some uses of it or take no action at all.

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